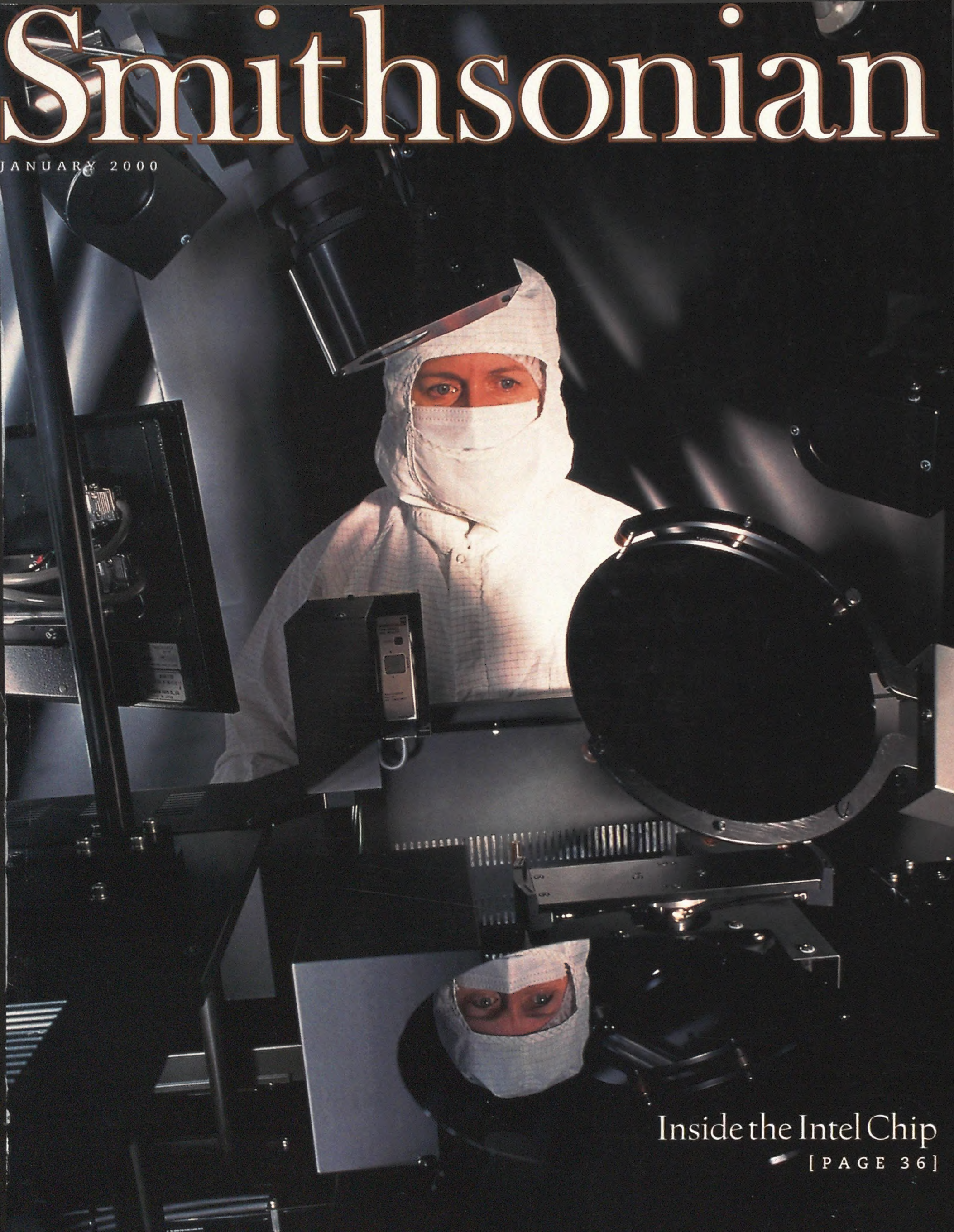
# Smithsonian

JANUARY 2000



## Inside the Intel Chip

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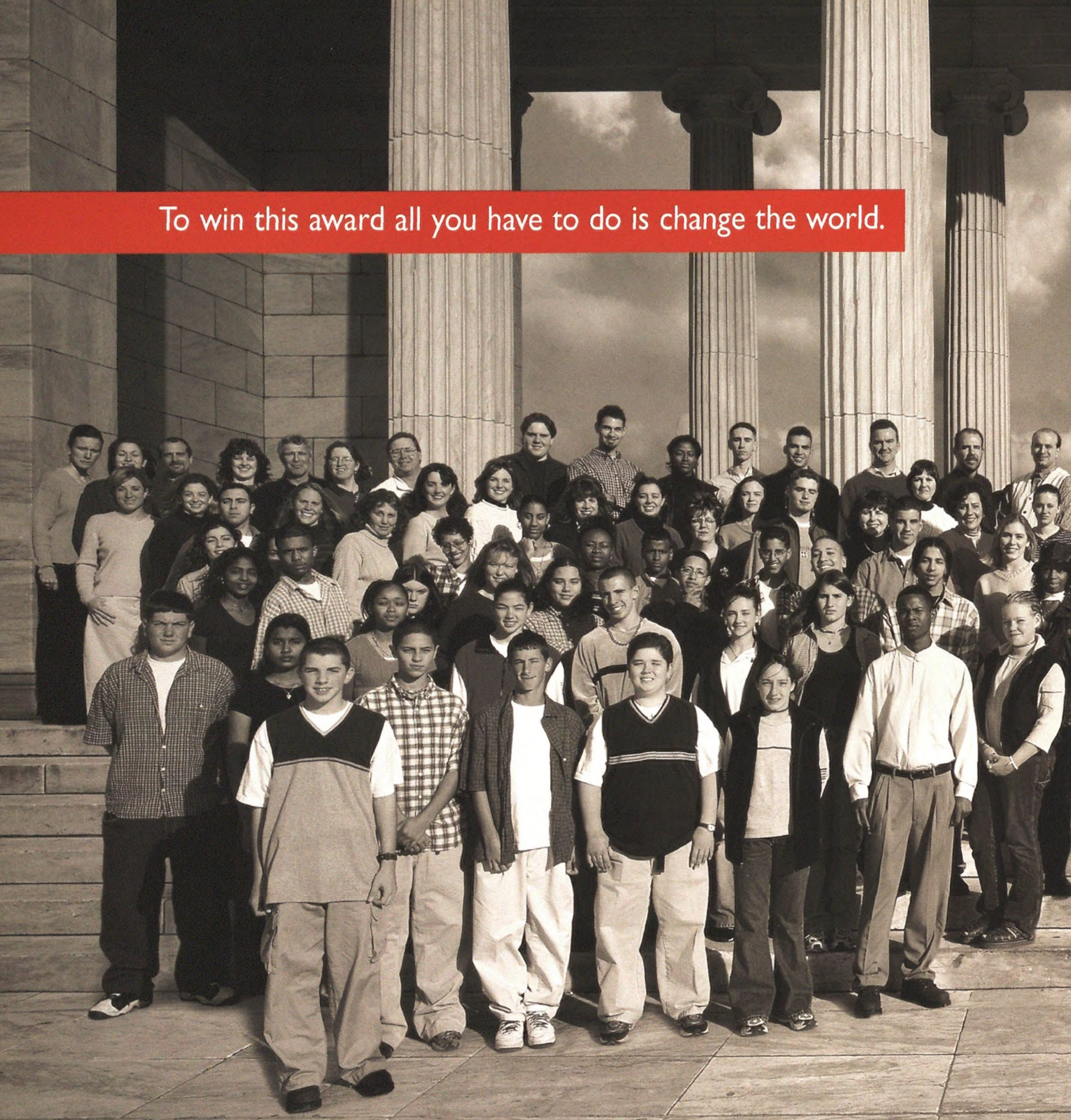


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# departments

JANUARY 2000 ♜ VOLUME 30, NUMBER 10

Cover In a black tent at Sumitomo Sitix, in Phoenix, Arizona, Carrie Sielski uses a light as bright as an airplane beacon to check silicon wafers for dust and other impurities. Wafers that pass this final test are sent to chip makers such as Intel.
PHOTOGRAPH BY KAY CHERNUSH

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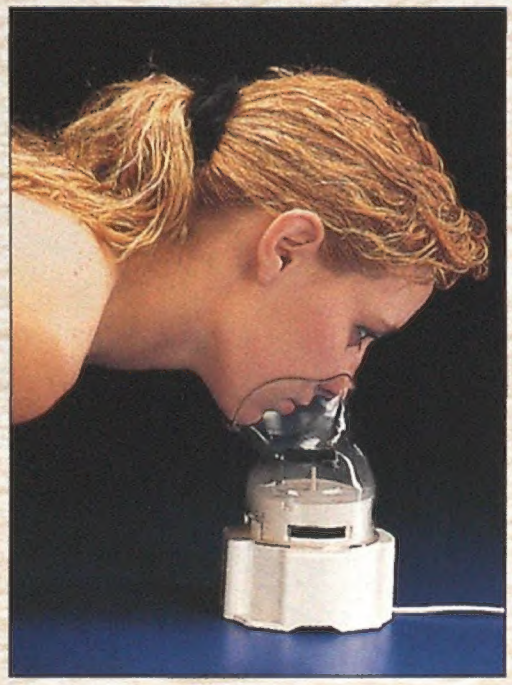

Unlike old fashioned vaporizers, this steam inhaler won't injure delicate membranes, adding to your discomfort. Its unique design creates a controlled, gentle stream of steam. And, the scientifically designed soft hood allows air to mix with the steam, allowing comfortable, natural breathing. The patented grille design lets you control the flow of steam precisely, making it safe for both adults and children. Compact and lightweight, it's easy to use at home, the office or when traveling. Fill it with only 1.5 oz. of tap water, and get up to 30 minutes of steam therapy. Automatic dual-voltage capability for use in the U.S.A. or abroad. ***Special Added Bonus!*** -- Six Aromatic Inhalant Pads -- soothing menthol vapors to help relieve congestion. ***$49.95*** ($7.95) #4050.

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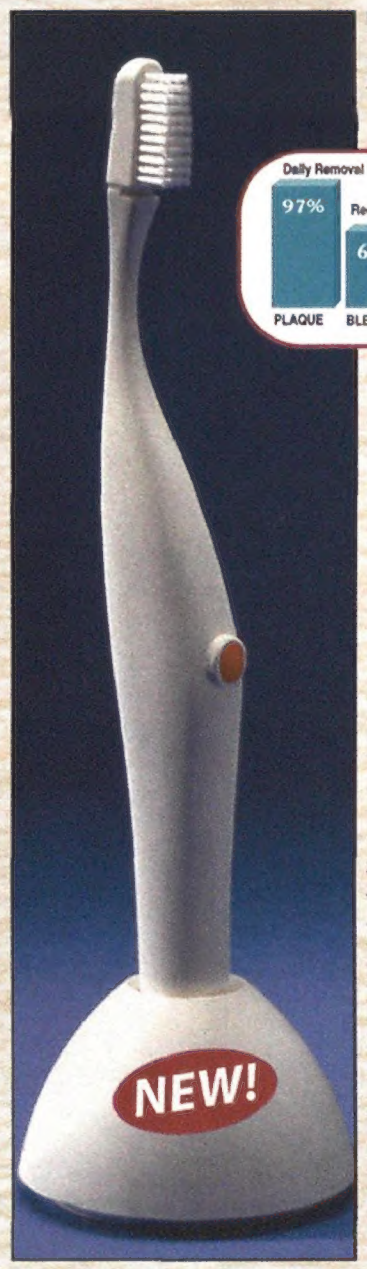
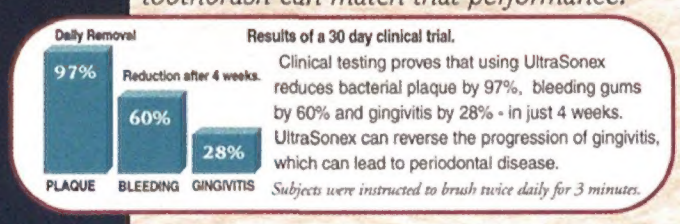
## Dual wave technology eliminates 97% of plaque!




The new dual-wave *Ultima* toothbrush from Sonex eliminates 97% of plaque with each 3-minute brushing. *No other toothbrush can match that performance.*


Daily Removal
Results of a 30 day clinical trial.
97%
Reduction after 4 weeks.
60%
28%
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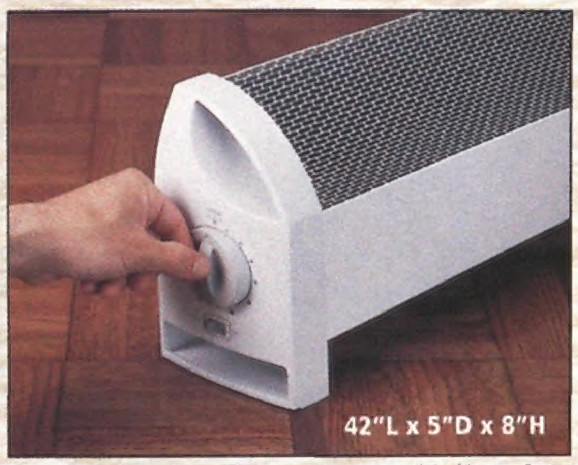
BLEEDING
GINGIVITIS
Clinical testing proves that using UltraSonex reduces bacterial plaque by 97%, bleeding gums by 60% and gingivitis by 28% - in just 4 weeks. UltraSonex can reverse the progression of gingivitis, which can lead to periodontal disease.
Subjects were instructed to brush twice daily for 3 minutes.

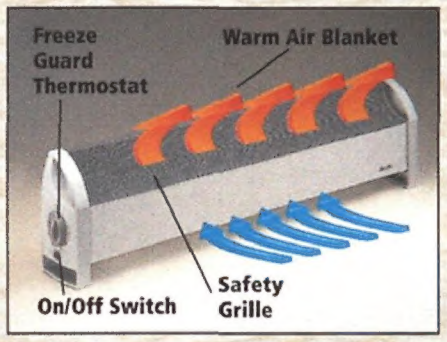
Ultima, from the makers of the original ultrasonic toothbrush, is *the first and only toothbrush to combine the two most advanced technologies in home dental care* — the plaque destroying power of ultrasound and the gentle, deep cleaning wave action of sonic vibration. Together they remove virtually all bacterial plaque, not only in and around your teeth but deep below the gum line where other brushes can't reach. Deep penetrating 1.6MHz ultrasonic waves penetrate the gum line to a depth of 5-millimeters destroying the bacteria that cause gingivitis and bleeding gums. At the same time, sonic waves gently vibrate Ultima's brush head at 18,000-strokes-per-minute to whisk plaque and other trapped particles from in and around your teeth. Use every day, twice a day and you'll maintain that fresh from the dentist clean feeling. And you'll likely avoid big dentists bills later. ***$129.95*** ($13.95) #9985. *Free with your order a $29.95 value - 3 replacement brushheads -a year's supply!*

# A toasty warm blanket of air

## Kwik Comfort -- the fastest source of safe, silent heat




Kwik Comfort™ by Slant/Fin, uses natural convection to evenly distribute heat throughout the room -- the same way the most sophisticated home baseboard heating systems do. Kwik Comfort draws in cool air and passes it over a revolutionary, aluminum speed-heating element that warms room air up to 20% faster than ordinary electric heating elements. The toasty warm blanket of air then distributes evenly throughout the entire room. There's no rumbling, clattering, or whirring fan noise to disturb a good night's sleep. What's more, Kwik Comfort is loaded with safeguards -- a finger proof grille, a full length high-temperature safety shut-off that prevents overheating and no accessible concentrated heat source or dangerous glowing hot coils. Other safety features include a low center of gravity to help prevent tip-over and a polarized plug. An automatic freeze-guard thermostat allows you to tailor heat output to your own comfort level and it will turn the heater on automatically if the room air temperature drops below 41°F. Its beautiful, streamlined design fits easily and unobtrusively in any room. Ruggedly constructed and UL-listed, Kwik Comfort will meet your heating needs for years to come. ***$89.95*** ($12.95) #7560.




# The Navy SEALs dive watch

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Now you can own the watch that was officially selected by the U.S. Navy's Special Forces SEALs (Sea, Air & Land), for use in their underwater operations. Made by Luminox, this rugged dive watch is the brightest reading watch for low or no light situations available. The secret is tritium micro-gas lights. Each hand and hour marker contains an impermeable borosilicate glass vial, the interior of which is coated with a phosphor and filled with tritium ($H_3$), an exotic hydrogen isotope. The result is a watch whose hands and hour markers glow – *unaided* – 100 times brighter than conventional watches. What's more, the SEAL watch will glow brightly unaided for 25 years. Swiss-made with a multi-jewel Swiss quartz movement, the SEAL Dive Watch is water-resistant to 20 ATM (660 feet), has a scratch-resistant tempered glass crystal, 24-hour dial, date window and a shock-resistant polymer case. Available in Black, Blue or Yellow face. ***$199.95*** ($9.95). #9470.

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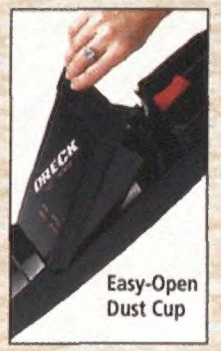


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# The Wonder of Iron-12

*Iron oxide bacteria, which live in a harsh environment equivalentto Mars, have many benefits for mankind.*

## Iron-Eating Organisms

*By Tomoyuki Kohara*

In 1976, America's space crafts, Viking I and II, transmitted images of Mars, revealing a harsher environment than previous impressions. Photographs revealed a surface of desert, strewn with reddish brown rocks, which are rich in ferric oxide, which is iron ore, along with an abundance of clay-based minerals. Scientists presume that the reddish brown color is due from oxidation by ozone action, or was spread by meteorites.

On earth, we may be seeing related activity. Iron oxide bacteria are organisms on earth that exist in a harsh environment like Mars, in strong acidic solutions in places like mines. These bacteria derive their energy for growth by oxidizing $Fe^{++}$ to $Fe^{+++}$, growth which is slow, since it is done without photosynthesis.

Iron oxide bacteria can be used in a system called bacteria leaching, in which iron-eating organisms leave minerals behind. Although this is an unusual organism, minerals can be obtained with a virtual 100% success rate, even from deposits of low grade ores. From exhausted mines, it is possible to obtain high grade minerals. Leaching has already been used in obtaining copper, manganese, bismuth, zinc, and molybdenum. The leaching system has also been useful in disposing of waste water. While it takes a lot of time, high rates of extraction are the end result.

Science fiction writer, Ray Bradbury, suggested in his *The Martian Chronicles* that man would take these iron oxide bacteria with him to Mars. Perhaps they are already there.

*About the Author:*
*Tomoyuki Kohara is a science journalist in Japan. His special interests include materials of the life sciences, global environment, and eco-systems.*


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A NOTE FROM THE SECRETARY

# Increase, Diffusion and . . . INSPIRATION

WHAT AN HONOR IT IS TO HAVE MY FIRST COLUMN appear in SMITHSONIAN during the first month of the year 2000. It is a thrill and a privilege to lead the Smithsonian at a time when knowledge is expanding at the fastest pace in human history, making this institution more important than ever.

When James Smithson, an English scientist, died 171 years ago, he left a will saying that if his nephew died without children, his considerable fortune should go to the United States "to found at Washington . . . an establishment for the increase and diffusion of knowledge among men." That is precisely what happened after Congress set up the Smithsonian Institution in 1846. But not even James Smithson could have imagined what his legacy would mean to the American people.

Nothing in the world is remotely analogous to the Smithsonian. The world's largest museum complex, it has 16 different museums and galleries, the National Zoo and a variety of major research facilities. More than 400 buildings contain roughly 7.5 million square feet, the equivalent of 156 football fields. The collections held by the various divisions of the Smithsonian are huge, global in scope, and of incalculable value. With more than 140 million objects and specimens—not counting holdings in libraries and archives—less than 2 percent of our collection is on display at any one time.

Millions of specimens document the minerals, rocks, gems, plants, insects, mammals, birds, amphibians and reptiles of the United States. We have the world's largest, most important collection of American Indian objects, and an unparalleled assembly of archaeological and ethnological items. We have thousands and thousands of items representing European, African, Hispanic, Middle Eastern, and Asian and Pacific Island history and culture. Together, it is a cultural pageant that tells the wondrous story of the United States' attracting people from around the world and forging a democratic society, the most innovative and productive force in world history.

You will find George Washington's tent here, the desk on which Jefferson wrote the Declaration of Independence, Bell's early telephones, the *Spirit of St. Louis*, the Wright Brothers' plane. Also here are more than 50,000 American artworks dating from Colonial times to the present, and some 13 million items in the world's largest archival collection documenting the history of art in America. And, of course, the Smithsonian has thousands of other books, films, records, tapes and compact disks covering just about every aspect of America's history.

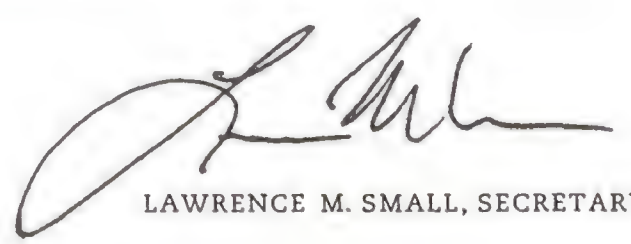
Essentially, the Smithsonian Institution is our national center of cultural heritage, the repository of the creativity, the curiosity, the innovative spirit and the courage of conviction of the American people. A look at the achievements of those who have come before us underscores how resourceful and ingenious Americans are. It drives home how willing our society has been to accept challenges.

As we prepare for our journey through the 21st century, the Smithsonian has an even greater role to play than in the past. Our nation is more populous than it has ever been—273 million strong. In addition, the country now has the largest absolute number of residents in its history who were born somewhere else—one out of every ten people. The challenge of providing educational resources to those who have come from elsewhere, as well as to all other U.S. residents, so they can learn about our past achievements, our current accomplishments and our future prospects, is enormous. I shall talk about how the Smithsonian plans to meet that challenge in future notes.

Last year, more than 35 million visits were made to exhibitions created by the Smithsonian. No other educational and cultural institution has visitation of this magnitude. Some people learned how the earth was formed, others about plant and animal life in North America. Some encountered works of art that gave them pleasure or fired their imaginations. Still others discovered aspects of American history that they had not known about before.

More important, millions of people were **INSPIRED**. Inspired by what has gone into creating a great nation and a great people, and by who we are today. Inspired by our national past to be optimistic about the future.

Secretary I. Michael Heyman and his team can be justly proud of the momentum they generated during the past five years. The Smithsonian Institution approaches the 21st century with the same sense of promise it held at the time of its creation. Alive and well, it has become more than anyone ever dreamed. And in doing so, it has added a major role to its mission of increase and diffusion. It has become an engine of **INSPIRATION** to us all.



LAWRENCE M. SMALL, SECRETARY

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*This is one fact about* VIAGRA *that most everyone is familiar with. Millions of men with erectile dysfunction* (ED) *have enjoyed more satisfying sex lives because of* VIAGRA. *But here are 7 more facts about* VIAGRA *that may be useful to you.*

## 1 VIAGRA is effective in men with all types of ED

VIAGRA improves erections in up to 4 of 5 men who take it compared with 1 out of 4 for sugar tablets, regardless of how severe their ED is, how long they have had ED, what caused it, or even how old they are. If you're not satisfied with your sex life due to poor erections during recent months, talk to your doctor. You may be suffering from mild ED—and VIAGRA can help.

## 2 VIAGRA has been extensively studied

In fact, in clinical trials of more than 3000 patients, VIAGRA was proven to be effective while having an excellent safety profile. And you can feel confident knowing that more than 250,000 doctors have written more than 14 million prescriptions for VIAGRA, as of November 1999, for more than 5 million patients.*

## 3 VIAGRA works when you need it

VIAGRA begins working in as fast as 30 minutes, but it can be taken as much as 4 hours in advance of sexual activity. A general rule is to take VIAGRA about 1 hour before sex. That way, you can use the time to get intimate with your partner. Be spontaneous. Be playful. Have fun.

## 4 VIAGRA only works when you are sexually stimulated

When a man is sexually stimulated, the arteries in the penis relax, and more blood flows into the penis, creating an erection. VIAGRA works by helping the blood vessels in the penis to relax, thereby increasing blood flow to the penis.

With VIAGRA, you must be sexually aroused (physically, visually, etc) to get an erection. If you take VIAGRA and are not sexually stimulated in any way, nothing will happen.

VIAGRA is not a hormone, an herbal supplement, or an aphrodisiac. VIAGRA is a prescription medication that can improve the erectile function of most men with erection problems. So with VIAGRA, a touch or a glance from your partner can once again lead to something more.

*Data on file. Pfizer Inc, New York, NY.

For more information, call 1-888-4VIAGRA or visit www.viagra.com.

*Please see patient summary of information for* VIAGRA *(25-mg, 50-mg, 100-mg) tablets on the following page.*

## VIAGRA comes in 3 dosing strengths

With 3 different doses (25 mg, 50 mg, 100 mg), VIAGRA has a strength that works best for you. Like many medications, your doctor may have to adjust your initial VIAGRA dose if it doesn't produce the desired results or you're bothered by side effects. Do not take more VIAGRA than your doctor prescribes, and do not take VIAGRA more than once a day.

## VIAGRA works best on an empty stomach

But if dinner is in your plans, you can still take VIAGRA. However, taking VIAGRA after a high-fat meal (such as a cheeseburger and french fries) may cause the medication to take a little longer to start working.

## VIAGRA is well tolerated

Like all medications, VIAGRA can cause some side effects. These are usually mild and don't last longer than a few hours. In clinical trials, the vast majority of these side effects did not cause patients to stop taking VIAGRA. Some of these side effects are more likely to occur with higher doses of VIAGRA. With VIAGRA, the most common side effects are headache, facial flushing, and upset stomach. VIAGRA may also briefly cause bluish vision, sensitivity to light, or blurred vision. In the rare event of an erection lasting more than 4 hours, seek immediate medical help.

VIAGRA is not for everyone. If you're a man who uses nitrate drugs, never take VIAGRA—your blood pressure could suddenly drop to an unsafe level.

Be sure to ask your doctor if your heart is healthy enough to handle the extra strain of sexual activity.

If you have chest pains, dizziness, or nausea during sex, stop and immediately tell your doctor.

# good about VIAGRA

*Last year,* VIAGRA *helped millions of men and their partners find something that was missing from their lives. Isn't it time you found out more about* VIAGRA?

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*(sildenafil citrate) tablets*

Love life again.

L o v e  l i f e  a g a i n.

PATIENT SUMMARY OF INFORMATION ABOUT

VIAGRA®
*(sildenafil citrate) tablets*

**This summary contains important information about VIAGRA®.** It is not meant to take the place of your doctor's instructions. Read this information carefully before you start taking VIAGRA. Ask your doctor or pharmacist if you do not understand any of this information or if you want to know more about VIAGRA.

This medicine can help many men when it is used as prescribed by their doctors. However, VIAGRA is not for everyone. It is intended for use only by men who have a condition called erectile dysfunction. **VIAGRA must never be used by men who are taking medicines that contain nitrates of any kind, at any time. This includes nitroglycerin. If you take VIAGRA with any nitrate medicine your blood pressure could suddenly drop to an unsafe or life threatening level.**

**What Is VIAGRA?**

VIAGRA is a pill used to treat erectile dysfunction (impotence) in men. It can help many men who have erectile dysfunction get and keep an erection when they become sexually excited (stimulated).

You will not get an erection just by taking this medicine. VIAGRA helps a man with erectile dysfunction get an erection only when he is sexually excited.

**How Sex Affects the Body**

When a man is sexually excited, the penis rapidly fills with more blood than usual. The penis then expands and hardens. This is called an erection. After the man is done having sex, this extra blood flows out of the penis back into the body. The erection goes away. If an erection lasts for a long time (more than 6 hours), it can permanently damage your penis. You should call a doctor immediately if you ever have a prolonged erection that lasts more than 4 hours.

Some conditions and medicines interfere with this natural erection process. The penis cannot fill with enough blood. The man cannot have an erection. This is called erectile dysfunction if it becomes a frequent problem.

During sex, your heart works harder. Therefore sexual activity may not be advisable for people who have heart problems. Before you start any treatment for erectile dysfunction, ask your doctor if your heart is healthy enough to handle the extra strain of having sex. If you have chest pains, dizziness or nausea during sex, stop having sex and immediately tell your doctor you have had this problem.

**How VIAGRA Works**

VIAGRA enables many men with erectile dysfunction to respond to sexual stimulation. When a man is sexually excited, VIAGRA helps the penis fill with enough blood to cause an erection. After sex is over, the erection goes away.

**VIAGRA Is Not for Everyone**

As noted above (*How Sex Affects the Body*), ask your doctor if your heart is healthy enough for sexual activity.

**If you take any medicines that contain nitrates–either regularly or as needed–you should never take VIAGRA.** If you take VIAGRA with any nitrate medicine or recreational drug containing nitrates, your blood pressure could suddenly drop to an unsafe level. You could get dizzy, faint, or even have a heart attack or stroke. Nitrates are found in many prescription medicines that are used to treat angina (chest pain due to heart disease) such as:

- nitroglycerin (sprays, ointments, skin patches or pastes, and tablets that are swallowed or dissolved in the mouth)
- isosorbide mononitrate and isosorbide dinitrate (tablets that are swallowed, chewed, or dissolved in the mouth)

Nitrates are also found in recreational drugs such as amyl nitrate or nitrite ("poppers"). If you are not sure if any of your medicines contain nitrates, or if you do not understand what nitrates are, ask your doctor or pharmacist.

VIAGRA is only for patients with erectile dysfunction. VIAGRA is not for newborns, children, or women. Do not let anyone else take your VIAGRA. VIAGRA must be used only under a doctor's supervision.

**What VIAGRA Does Not Do**

- VIAGRA does not cure erectile dysfunction. It is a treatment for erectile dysfunction.
- VIAGRA does not protect you or your partner from getting sexually transmitted diseases, including HIV–the virus that causes AIDS.
- VIAGRA is not a hormone or an aphrodisiac.

**What To Tell Your Doctor Before You Begin VIAGRA**

Only your doctor can decide if VIAGRA is right for you. VIAGRA can cause mild, temporary lowering of your blood pressure. You will need to have a thorough medical exam to diagnose your erectile dysfunction and to find out if you can safely take VIAGRA alone or with your other medicines. Your doctor should determine if your heart is healthy enough to handle the extra strain of having sex.

Be sure to tell your doctor if you:

- have ever had any heart problems (e.g., angina, chest pain, heart failure, irregular heart beats, or heart attack)
- have ever had a stroke
- have low or high blood pressure
- have a rare inherited eye disease called retinitis pigmentosa
- have ever had any kidney problems
- have ever had any liver problems
- have ever had any blood problems, including sickle cell anemia or leukemia
- are allergic to sildenafil or any of the other ingredients of VIAGRA tablets
- have a deformed penis, Peyronie's disease, or ever had an erection that lasted more than 4 hours
- have stomach ulcers or any types of bleeding problems
- are taking any other medicines

**VIAGRA and Other Medicines**

Some medicines can change the way VIAGRA works. Tell your doctor about **any medicines** you are taking. Do not start or stop taking any medicines before checking with your doctor or pharmacist. This includes prescription and nonprescription medicines or remedies. Remember, VIAGRA should never be used with medicines that contain nitrates (see *VIAGRA Is Not for Everyone*). If you are taking a protease inhibitor, your dose may be adjusted (please see *Finding the Right Dose for You.*) VIAGRA should not be used with any other medical treatments that cause erections. These treatments include pills, medicines that are injected or inserted into the penis, implants or vacuum pumps.

**Finding the Right Dose for You**

VIAGRA comes in different doses (25 mg, 50 mg and 100 mg). If you do not get the results you expect, talk with your doctor. You and your doctor can determine the dose that works best for you.

- Do not take more VIAGRA than your doctor prescribes.
- If you think you need a larger dose of VIAGRA, check with your doctor.
- VIAGRA should not be taken more than once a day.

If you are older than age 65, or have serious liver or kidney problems, your doctor may start you at the lowest dose (25 mg) of VIAGRA. If you are taking protease inhibitors, such as for the treatment of HIV, your doctor may recommend a 25 mg dose and may limit you to a maximum single dose of 25 mg of VIAGRA in a 48 hour period.

**How To Take VIAGRA**

Take VIAGRA about one hour before you plan to have sex. Beginning in about 30 minutes and for up to 4 hours, VIAGRA can help you get an erection if you are sexually excited. If you take VIAGRA after a high-fat meal (such as a cheeseburger and french fries), the medicine may take a little longer to start working. VIAGRA can help you get an erection when you are sexually excited. You will not get an erection just by taking the pill.

**Possible Side Effects**

Like all medicines, VIAGRA can cause some side effects. These effects are usually mild to moderate and usually don't last longer than a few hours. Some of these side effects are more likely to occur with higher doses. The most common side effects of VIAGRA are headache, flushing of the face, and upset stomach. Less common side effects that may occur are temporary changes in color vision (such as trouble telling the difference between blue and green objects or having a blue color tinge to them), eyes being more sensitive to light, or blurred vision.

In rare instances, men have reported an erection that lasts many hours. You should call a doctor immediately if you ever have an erection that lasts more than 4 hours. If not treated right away, permanent damage to your penis could occur (see *How Sex Affects the Body*).

Heart attack, stroke, irregular heart beats, and death have been reported rarely in men taking VIAGRA. Most, but not all, of these men had heart problems before taking this medicine. It is not possible to determine whether these events were directly related to VIAGRA.

VIAGRA may cause other side effects besides those listed on this sheet. If you want more information or develop any side effects or symptoms you are concerned about, call your doctor.

**Accidental Overdose**

In case of accidental overdose, call your doctor right away.

**Storing VIAGRA**

Keep VIAGRA out of the reach of children. Keep VIAGRA in its original container. Store at room temperature, 59°-86°F (15°-30°C).

**For More Information on VIAGRA**

VIAGRA is a prescription medicine used to treat erectile dysfunction. Only your doctor can decide if it is right for you. This sheet is only a summary. If you have any questions or want more information about VIAGRA, talk with your doctor or pharmacist, visit www.viagra.com, or call 1-888-4VIAGRA.

23-5515-00-4

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*(sildenafil citrate) tablets*

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## THE OBJECT AT HAND

THANK YOU FOR "THE COLORS OF Childhood" by Beth Py-Lieberman in your November 1999 issue. Ah, to open a new box of Crayola crayons, to smell their distinct aroma and to view those pristine points—almost too perfect to use. Your description of their mass production could never take away that feeling of owning a complete and personal treasure full of promise, such as that those boxes held for each of us.

When my daughter was 7 years old she wrote an essay describing the things she would want most in life. Besides the 50 cats and a castle to keep them in, her wish was for "a new box of crayons, every day."

*Elaine Reese*
*Littleton, Colorado*

SOMETHING I HEARD ABOUT CRAYOLA crayons years ago still applies today: they don't break; they multiply.

*Michael D. Thomas*
*Santa Monica, California*

FOR THE PAST 20 YEARS, I SECRETLY wanted a brand-new, 64-color box of Crayola crayons. The desire was fueled by my memory of their wonderfully fresh and waxy aroma.

My reason for wanting the new box goes back to my youth. I had assembled a box of used crayons that I would share with friends, and I held back my new box of Crayolas. I never could convince anyone to use fuschia, chartreuse or raw umber for coloring landscapes or living rooms and was forced by social mores to bring out my newest box. I watched

in silent dismay as my playmates pushed my new Crayolas too hard and flattened the points, or as they tore off the wrappers in a spiral, making it impossible for me to see the name of the color, or used up the gold and silver first, coloring palominos and cowboy guns.

I never planned to use the new box of 64 crayons; I just wanted them close at hand so I could occasionally open the box and reverently touch those 64 pristine, unbroken points. Crayola crayons have always been tops in my coloring book.

*Phyllis O'Dell*
*Lexington, Kentucky*

OUR PRESCHOOLER DISAPPROVED OF stoplights. She declared that the colors should be pink, periwinkle and thistle—colors I later recognized inside her prized crayon box. At 14, she painted a large mural for a storefront church. Today, Mona is an artist. So you see, from small beginnings . . .

*Wallace F. Smith*
*Walnut Creek, California*

### ARMY-NAVY FOOTBALL

THANK YOU FOR THE ARTICLE "IT'S More Than Just a Game" by Bruce Watson. On December 7, 1963, the Army-Navy game made television history. CBS-TV broadcast the game and used "instant replay" for the first time. The technical crew had been concerned that the video tape recorder might not work, so they did not give anyone advance notice that the new feature was possible. The sports announcers were as surprised as everyone else when the first replay flashed across the screen.

*Lee Schaeffer*
*Pittsburgh, Pennsylvania*

THE STATUE IN THE ANNAPOLIS YARD that you mentioned is not a likeness of Tecumseh, the Shawnee chief.

*Glen Johnson*
*Cypress, California*

**The Class of 1891 gave the U.S. Naval Academy the bronze statue in May 1930. It replaced an old wooden figurehead from the USS *Delaware* that had begun to rot, and the original's wooden "brain" and "heart" were put inside the bronze version.**

**The wooden figurehead was brought to the Naval Academy around 1874-1876, but it did not bear any name. The figurehead soon became known to thousands of cadets as Tecumseh, but it is also known as the God of Two-Point-Five, because thousands of cadets have muttered prayers to it on their way to and from classes, asking for a passing grade of 2.5. Eventually records were uncovered indicating that the figurehead that had graced the *Delaware* was of Tamamend, who was a chief of the Delaware. The statue is not Tecumseh, but that is what he's called. Ed.**

### PHENOMENA, COMMENT & NOTES

EDWIN KIESTER, JR.'S INTERESTING column "A Darkness in Donora"

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contained a minor meteorological error. A temperature inversion occurs when a layer of warmer air traps a layer of colder air beneath it. Air temperature normally decreases as one ascends the atmosphere. A temperature inversion is a reversal of what is normal. In Utah, we often see this phenomenon in the winter when the ski resorts report sunshine and temperatures in the 50s at the same time the valley floors experience cloudy skies and temperatures only in the upper 20s.

*Thomas A. Carey*
*National Weather Service (retired)*
*Bountiful, Utah*

**Mr. Carey correctly defines a typical temperature inversion. In the case of Donora, the warm air over the colder lower layer of air trapped the mill's warm effluents, creating a dense smog that covered the town for five days. Ed.**

### FACING HISTORY

I ENJOYED READING THE ESSAY BY Angela M. Pleasants and seeing the pictures from Napolean Wilson's new book, *Hidden Witness: African-American Images from the Dawn of Photography to the Civil War*. The people could have been in my family album.

While attending a high school in Kansas, a teacher assigned us to write about our family history. Most of my classmates showed us antique heirlooms, photographs, coats of arms and letters. They could trace their ancestors' immigrations to America, wearing only the clothes on their backs and carrying the few trinkets that my classmates displayed.

As the only African-American in the class, my story was quite different. Looming in my history was the specter of slavery. I learned that day how important it is for people to have tangible evidence of their histories. Pictorial images are powerful, and people who never see themselves depicted historically are likely to have a reduced understanding of, and less pride in, their pasts.

*Alice Brown*
*Atlanta, Georgia*

### BELUGAS

THE CAPTION ON PAGE 87 IN STEVE Kemper's article "The 'Sea Canary' Sings the Blues" says "a St. Lawrence beluga today has less to fear from people than pollution." Pardon me, but who or what if not "people" created the pollution?

*Joseph L. Boucher*
*Indianapolis, Indiana*

### BIG SUR

THE ARTICLE ON BIG SUR BY ROBERT Wernick, with beautiful photographs

Over time,
some come to discover
what a special place this is.
Others just know by instinct.
For millions of years, loggerhead turtles and their families have enjoyed the splendid isolation of the North Carolina coast. Now it's your turn. For a free travel guide, call 1-800-VISIT NC, Dept. 680. www.visitnc.com
NORTH CAROLINA
A better place to be.

by Catherine Karnow, brought back memories of rollicking weekend escapes from a working girl's life in 1950s San Francisco. One evening was especially memorable. I dined on a hamburger at Nepenthe—that was all they served back then—danced on the deck for hours and then moved with the crowd to Big Sur Inn. I was sitting at the dining room piano with Henry Miller, playing "Chopsticks," when a fight broke out at the bar, but it was over before our song was.

*Shirley Stasko*
*Calusa, California*

THE BIG SUR INHABITANTS THAT YOU described struck me as an overglorified, overglamorized bunch of dysfunctional, primitive, perverted human beings who lacked the backbone to cope with life. Some of them, such as Henry Miller, lucked into benefits they didn't deserve. No one should receive acclaim for telling us about the sordid. It is all around us; we don't need to be told. It is the main reason for seeking wealth: to escape mankind's miserable existence.

*Virginia E. Arnett*
*Petoskey, Michigan*

"THAT FIERCE-LOOKING YOUNG MAN," Hunter S. Thompson, is a native of Louisville, Kentucky, not Missouri.

*John Boyle*
*Springfield, Oregon*

IN THE 1950S, I WAS STATIONED AT the Naval Auxiliary Air Station in El Centro, California. Although I came to love the desert and its solitude, I longed for the fog, the greenery and the dampness of the Northern California coast. When I could get leave, I packed my camping gear and headed up the coast. On Highway 1, I drove for hours without seeing more than three other cars. The greatest experience of my life was being the only camper in Big Sur State Park. It will never happen again.

*Albertlea Hanson*
*Oroville, California*

**WRITE TO SMITHSONIAN**

Letters for consideration in this column must include your full name, street address and daytime telephone number. Transmit mail to LettersEd@simag.si.edu or send it to Smithsonian Letters Editor, P. O. Box 44400, Washington, D.C. 20026-4400. Letters may be edited for clarity and length. Send all other queries and comments to Smithsonian, 900 Jefferson Drive, Washington, D.C. 20560-0406.

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THE OBJECT AT HAND

# A Mystery in Miniature

## AN ENIGMATIC BUTTON ONCE DECORATED THE UNIFORM OF HAITIAN LIBERATOR TOUSSAINT LOUVERTURE

**BY ANN GERACIMOS**

THE OBJECT AT HAND IS A SMALL, ROUND, BRASS-rimmed image covered with glass. At an inch and a half in diameter, it is large as buttons go. But as a painting—painstakingly done with oils on canvas over bone—it is minuscule. In that small compass the artist has nevertheless managed to present an enigmatic encounter between a woman, perhaps white, two sumptuously dressed black women and a single black man. The man could be a chief. At least he is wearing a feathered headdress—though not much else—and he seems to be making an imperious hand gesture to the woman by the doorway.

Its meaning lost today, this picture button's mute tableau must have spoken volumes to its 18th-century Haitian wearer.

Experts at the Smithsonian's Cooper-Hewitt, National Design Museum in New York, where the picture-button comes from, are not certain what the scene intends to convey. The button is one of a set of 18 painted by Agostino Brunias or perhaps by someone of his school. Brunias was an Italian who worked with the famous architect Robert Adam in England before heading off to the West Indies around 1770. In the 1790s the buttons likely adorned the dressy waistcoat of the ultra-dressy uniform of Toussaint Louverture, Haiti's greatest liberator, who astonished the world by his triumphant and complex role in the bloody international struggles over slavery and control of the island of Hispaniola during the period of the French Revolution.

Picture buttons were popular among men of fashion in the 18th century. "Two thirds of the buttons made before 1820," Carl Drepperd notes in *The Complete Button Book,* "were made for the use of that once proud peacock, the male of the species. Kidd, the pirate, wore silver and gold buttons. So did every pirate. It was a means of combining utility with value on one's own person. A man with a suit embellished with twenty gold and sixty silver buttons was never broke." It is possible, too, that the button scenes represented Haitian life as Toussaint hoped it would become, free of slavery and perhaps even of discrimination by shadings of skin color—from white to mulatto to black—which were responsible for so much of the discord in the colonial world of the West Indies.

In such a utopian, revolutionary view, the man in this picture could be the African chief from whom some believed Toussaint was descended, addressing a woman, conceivably the wife of a white planter. In any case, in the late 18th century, drawings and paintings of people of color decked out in fancy European costumes and state regalia may have offered ways of representing the formal acquisition of a new liberty and sophistication associated with the declaration of the Rights of Man in far-off Paris in 1789. As a leader Toussaint generally preached—and practiced—the puritan virtues of discipline and hard work, although he was well known for wearing an elegant, fashionably cut coat with decorative buttons and an elaborate feathered tricorn hat, the hat especially adding stature and allure to what one writer describes as "his homely, short, small-framed" appearance. But images of him exist without that particular coat and hat.

The man who became the 18th century's most successful enemy of slavery was born a slave in 1743. Briefly schooled by the Jesuits, he became a coachman and plantation steward, and then was freed at age 34 after teaching himself the rudiments of herbal medicine. Haiti was then St. Domingue, the French portion of the island of Hispaniola; Spain held the rest. After the French Revolution broke out

MATT FLYNN /COOPER-HEWITT/ART RESOURCE

*Hated by monarchies and slave owners, he was known as the "Bonaparte of the Antilles."*

in Paris, an ill-organized slave uprising exploded in St. Domingue. Soon both Spain and England were fighting to take over the French colony, rich in sugar, coffee, cotton, cocoa, tobacco and indigo. Toussaint joined the slave revolt in 1791, giving it leadership and organization during years of savage fighting and three-way racial war between whites, blacks and mulattoes. Eventually he joined his forces with the Spanish against the French; and as a general he defeated both English and Spanish forces. By then, he had switched back to the French side because, alone among the warring powers, the government of France had officially outlawed slavery.

By 1796 Toussaint was Haiti's lieutenant governor—soon to be governor general. Foreign countries dealt with him directly. Trying to rebuild a land ruined by war, he instituted forced labor but shared profits with the workers and did away with floggings. He negotiated better trade arrangements with the British and the newly freed American Colonies. Hated and feared by monarchies and slave owners, he was now widely known as the "Bonaparte of the Antilles." Yet the government of President John Adams recognized him, sent a diplomatic representative and dispatched American Navy ships, which helped him fend off various attacks. With a little advice from a surprising source, former Secretary of the Treasury Alexander Hamilton, he had a new constitution written for Haiti, reorganizing the country and giving himself as governor nearly absolute power. In 1801 he became master of the whole island of Hispaniola by attacking what is now the Dominican Republic, killing Spanish colonists but freeing the slaves.

Meanwhile, the real Napoleon Bonaparte, now in charge of the French government, had decided to retake Haiti, depose Toussaint and reinstate slave labor so Haiti could once again become a hugely profitable French colony. In 1802 he sent 30,000 soldiers under General Leclerc to do the job. After bloody fighting, Toussaint joined other black leaders in coming to terms with France. He laid down his arms only after extracting a promise from Leclerc that slavery would never be reinstated in Haiti. Shortly afterward he was tricked into a meeting with one of Leclerc's generals and made a prisoner. Many people wanted him out of circulation for good, most notable among them Thomas Jefferson, who after becoming President in 1801, reversed American policy toward Toussaint. Jefferson feared that a successful slave revolt in the Caribbean might be imported to the Southern United States, with bloody results. He did not want any successful slave leader free to stir up trouble. In addition, he had a great weakness for all things French. Toussaint was duly shipped off to prison in France.

Born a slave in 1743, Toussaint Louverture led the long struggle to end slavery on the island of Hispaniola. He died in 1803.

GRANGER COLLECTION

Copies of letters on file at the Cooper-Hewitt suggest that a boy who befriended Toussaint in prison was given the fancy coat in exchange for his kindness. Another account simply says that the garment and buttons somehow found their way into the hands of a prison guard. At some point, the 18 buttons wound up in the possession of a college professor in the Ardennes in France, who sold them to a Frenchman named Jean Milare. Then, the trail of the buttons grows murkier still, until 1939 when they were bought in Paris by Pauline Riggs Noyes, the millionaire American wife of an adventurer named Robert Noyes. When war broke out in Europe, she apparently brought the buttons back to New York, where by coincidence they were seen by costume designer Miles White. He promptly put them to use as inspiration for costumes in *The Pirate*, a Broadway farce by S. N. Behrman set in the West Indies, and starring Alfred Lunt and Lynn Fontanne. After Pauline Noyes' death, in 1942, the buttons were given to the Cooper-Hewitt, where they are periodically on display.

Toussaint eventually ended up half-starved and shivering in a damp, cold fortress near Besançon in the French Alps. There, in April 1803, he obligingly died. As it happened, that same year many of Napoleon's soldiers in Haiti died of yellow fever. Those who didn't were defeated by what was left of Toussaint's army, commanded by Jean-Jacques Dessalines and Henry Christophe (SMITHSONIAN, October 1987). By 1804 Haiti had once and for all declared its independence. Its history has since been stormy. But from the time of Toussaint's power, there was never to be slavery in Haiti again.

# A Renaissance Man

FROM FINANCE TO FEATHERS, SECRETARY LAWRENCE M. SMALL BRINGS DIVERSE TALENTS TO THE SMITHSONIAN

BY MICHAEL KERNAN

An avid collector, Secretary Small (here, surrounded by Amazonian headdresses and masks) visits his gallery often.

KAY CHERNUSH

BENEFACTOR JAMES SMITHSON would have been delighted.

Lawrence M. Small, the new Secretary of the Smithsonian, comes to the Institution from the number two post of president and chief operating officer at Fannie Mae, the huge federally chartered mortgage investment company. Before that he logged 27 years rising to the top at the global financial firm of Citicorp/Citibank. But when I visited him recently at his Washington, D.C. home, it was clear that, as he said, his "interests go beyond the typical financial drone."

It was what you would call an understatement.

We left his house and drove a few blocks to an apartment complex, and there he let me into a vast suite—2,500 square feet—that he and his wife have turned into a private gallery. It is a museum of Amazonian tribal art.

Still unfinished, it has already won an American Institute of Architects award for design. Not even a third of the thousand-plus items collected by Small and his wife, Sandra, from the Amazon region of Brazil are displayed, but what is there is wonder enough. There are headdresses, capes, masks, nosepieces, labrets and armbands, all festooned with feathers of every conceivable color and size, from foot-long macaw feathers to fingernail-size hummingbird feathers. The

combinations of colors dazzle the eye wherever you look.

"Some people call this 'primitive art,'" Small said. "But, as you can see, it's quite complex. The ability of the artists of the rain forest to work with color, form and a considerable variety of natural materials is highly sophisticated." He then led his pop-eyed visitor through one breathlessly beautiful room after another.

And the collection is just for the enjoyment of family and friends. "We've never sold one piece in our lives," Small said. "But we were getting crowded out of our house by all that art." He is right. His house is a sumptuous, spacious place with marble floors and chandeliers, banquet tables and book-lined studies, but it was filled right up with statues from Africa and New Guinea, mud men masks, tribal art from New Guinea and the Amazon, wooden effigies and a Papua New Guinea spirit mask the size of a Fiat.

Small, 58, has served on more than a dozen boards, committees and organizations, ranging from the Spanish Repertory Theatre in New York City to the U.S. Holocaust Memorial Council to Morehouse College, a historically black institution in Atlanta. How does he do it? "I'm just interested in what I do," he said. "You could not do what I've done in my life and be bored with your work. I don't think it's a question of ability; it's just being interested in people."

And music. It was a Carlos Montoya record of flamenco guitar that sparked a lifelong passion. Small remembers exactly which step of a Brown University dorm staircase he was stepping on when he heard the music coming from someone's room. He was a freshman. He was 18 and wondering what he was going to do with his life.

"I was completely overwhelmed by what I heard," he told me. "I became obsessed. By the time I hit the top step I said to myself, 'I hereby dedicate myself to becoming the greatest flamenco player in the world.' That was 40 years ago."

It was no idle daydream. Small found a flamenco teacher named Fidel Zabal, a clerk at ITT in New York City, and commuted scores of times from Providence to the old man's walk-up flat. The kid was good, all right, but eventually Zabal told him, "You will never be famous unless you go to Spain."

So Small made plans to go to Spain. Alan Trueblood, a professor in the Spanish-Portuguese department at Brown, put him in touch with a Smith College overseas program. Now a sophomore, Small audited a Spanish course in addition to his regular load and squeaked by on a competency test. He then flew to Granada two months before the program was to start. By the time the other students arrived, he was miles ahead of them, speaking Spanish fluently. Meanwhile, he kept working on his guitar.

*His house was filled with tribal art, wooden effigies and a spirit mask the size of a Fiat.*

"Then I made a list of the top ten flamenco players in the world," he said with a wry smile, "and they were all Spanish gypsies, all 5 feet 6, with bronze skins, all child prodigies. And here I am, 6 feet 3, a suburban kid from New Rochelle, New York."

The dream changed, but not much. He loved living abroad and his language skills were very marketable, so he decided to work for Citibank, which was expanding in Latin America. Professor Trueblood was appalled: business was taking one of his best Spanish literature students ever. But he wished him well and, at a graduation dinner, gave Small a volume of Wallace Stevens' verse, which included not only the famous poem "The Man with the Blue Guitar" but the appealing tidbit that Stevens, a Pulitzer Prize-winning poet, had also been an insurance executive.

With the bank job as his passport and his fluency in Spanish, Small took a position in Chile. And there he met Sandra, an American student, also fluent in the language. Today she is an interpreter in the federal court system in Washington. The Smalls continue to explore languages (he also speaks Portuguese and French) and the world itself, traveling whenever and wherever they can.

The couple's daughter, Amy, is studying fine arts in the Midwest, and their son, Martin, is a law student in New York (and a rock guitarist). Small's mother, former dean of Walton High School in the Bronx, still lives in New Rochelle, and his stepfather, a retired finance executive, is a painter. A striking abstract expressionist work by him hangs over the mantel in Small's living room.

Family is very important to Larry Small. "When I came to Fannie Mae in '91," he said, "I commuted from New York to Washington for 23 months, rode the shuttle 300 times, because my son was entering 11th grade in New York City and we just didn't want him to have the stress of moving right then."

Small was planning to retire two years from now "and devote my life to music, art and languages," but when the Smithsonian asked him to consider becoming its 11th Secretary, Small realized that this would be a perfect assignment. "It's not work, it's total enjoyment."

He has a similar attitude about his guitar. When asked if he practices, he replies: "I don't practice, I play." He might play for 15 minutes, or he might play for two hours, running through a phrase 400 times. Learning from old records, he sometimes puts an impossible-sounding guitar passage

At home, under the watchful eye of an orator's stool from Papua New Guinea, Secretary Small serenades his wife, Sandra, with flamenco music.

on slow-time until he can learn all of the notes. "I lose myself in it. It's not taxing a bit."

He played for me, his amazingly extended, elegant fingers—the nails on the right hand are extra long—rippling over the fingerboard, pecking the surface to imitate the clack of heels, producing the fiery flamenco music as rich, exotic and intricate as Moorish filigree. Maybe it wasn't the tenth-best in the world, but it was good.

"I have no misconceptions about how well I play," he said. "It's not important. I just want to keep working."

I detected the same enthusiasm and drive in his plans for the Smithsonian. "I think there's clearly a tremendous opportunity for us to be far more meaningful to the American people," he said, "by developing a presence all around the country. I don't mean branches, but more of what is already being done."

We were talking about the Smithsonian's staggering collection of more than 141 million items, of which he doubts that even 2 percent are on exhibit. He hasn't yet had a chance to visit the Institution's vast storage and

*"The Smithsonian name and reputation command a public, so the problem is to get to that public."*

conservation facilities in Suitland, Maryland, with their thousands and thousands of pots, skeletons, spears and shields, fish, fossils and, reportedly, the brain of explorer John Wesley Powell. But he has a grasp of the basic issue, the sheer quantity of stuff owned by the Smithsonian.

"There are so many institutions that don't have extensive collections and would love to have long-term loans of objects from the Smithsonian as well as a permanent relationship with us. The Smithsonian Institution Traveling Exhibition Service [SITES] is a huge success; it always has 40 to 50 shows traveling at any one time, and they are seen by millions of people. The Smithsonian name and reputation command a public, so the problem is to get to that public.

"It's no innovation on my part—the Smithsonian has already figured it out—but I can emphasize what is already a priority, and I look forward to working with members of Congress, who are fabulous conveners of people and resources in their areas."

The new Secretary envisions the Institution "building affiliations all over the country that will allow millions more to enjoy, learn from and be inspired by this collection of national treasures."

Plus, of course, there is the virtual museum. He told me of his visit to the Smithsonian's Astrophysical Observatory, which has robotic telescopes that provide images via the Internet, allowing students and teachers to download, say, a view of the moon. "Five years from now, there will be hundreds of times as much of this sort of thing available," Small said. "We will be delivering the Smithsonian virtually through electronics, in addition to delivering it physically by greater activity, to diffuse knowledge. This is a new age, as far as teaching materials go."

As a member of the Smithsonian Luncheon Group, an Institution outreach organization, Small has been thoroughly impressed by the high quality and vast experience of Smithsonian people. Recently he was talking to Michael Robinson, director of the National Zoological Park.

"We got onto New Guinea, and he said he'd lived there four years. Then we talked about Latin America. Oh yes, he'd lived in Panama eight years. And then I said my wife and I loved India, it's our favorite country for tourism and studies, and he said, oh yes, he'd just got back from there."

So if anyone wants to know how Larry Small manages to do it, starting at 8 A.M. and going to 8 P.M., attending meetings back to back, he'll say, "It's fun. It's like watching the greatest show on earth."

KAY CHERNUSH

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POINTS OF INTEREST

# Inexplicable Moments

## STRANGE THINGS HAPPEN AT THIS WACKY CROSSROADS OF THE HOPELESSLY ALIEN-ADDLED IN THE NEVADA DESERT

BY DONOVAN WEBSTER

Patrons of the Little A'Le'Inn re-create the mysterious cylinder of light that allegedly pierced the solid steel door a few years ago.

EXCEPT FOR THE SILVERY IMAGES OF BULBOUS-EYED aliens that decorate the place, the boxy structure at one end of the only paved street in Rachel, Nevada, looks pretty much like any other roadhouse in the American West. But what goes on inside this saloon and, some say, in the night sky overhead has rendered the Little A'Le'Inn (get it?) one of the most intriguing spots on earth.

Each year, thousands are drawn to this windswept town of about 100 year-round residents as if by supernatural force. "The thing that gets us attention," the inn's motherly proprietress, Pat Travis, is telling me, "is our location—we're about 25 miles from Area 51. Many people think Uncle Sam is hiding at least nine alien spacecraft out there. Many also believe six alien beings, not all of them dead, are kept there, too: a large- and a small-nosed gray, an orange, a blue, one reptile and a humanoid."

Pat's husband, a tall, white-haired gent named Joe, stands behind the long bar peering out a window at the birdbath he's just refilled. Sunset drapes the desert in gold. "Some people say this is a little crazy," he concedes. "But everybody still comes and looks—beautiful folks from all over the world." As if on cue, a dark-haired woman walks through the door and sits at the bar. She orders a soda, revealing a European accent. "Where you from?" Joe asks.

"The Netherlands," she replies. "I'm on a business trip. I've heard so much about this place—the spacecraft, the aliens, your restaurant—I had to see it."

PETER MENZEL (2)

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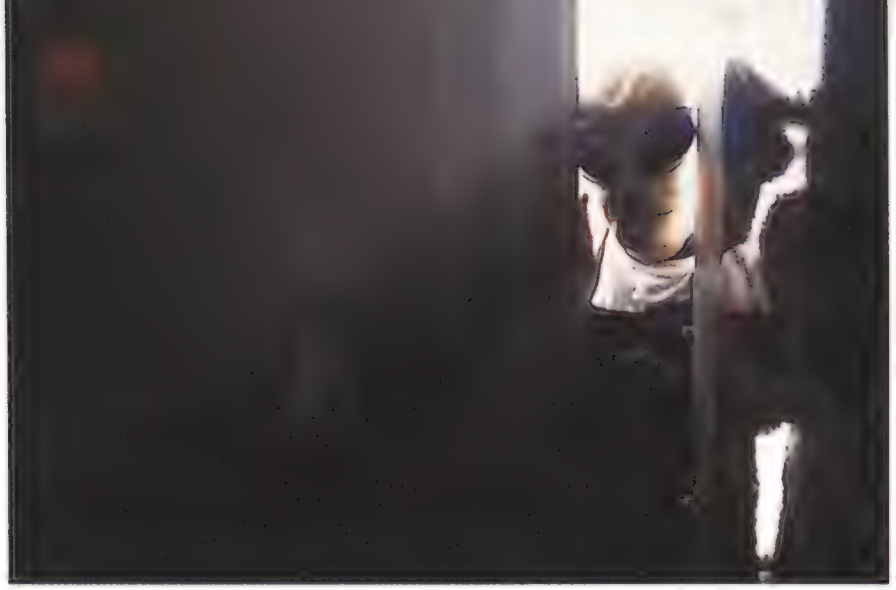

An unidentified visitor, possibly a waitress in disguise, sizes up the joint. Some of the inn's human customers are even stranger.

"There's what I mean," Joe says to me. "I don't think about us as some sort of alien spot. We're more like a crossroads."

Rachel wasn't even a crossroads, much less a town, until fairly recently. Silver miners started settling the hills and valley near Tempiute Mountain in the late 1800s. Union Carbide opened a tungsten mine in the 1970s, which sparked modest growth. A bar and restaurant on the north end of town, called the Rachel Bar and Grill, was a struggling concern until Pat and Joe Travis bought it in the summer of 1988. Although they didn't know it then, they were on the verge of something strange and wonderful.

Sprawling southwest of Rachel is an expanse of desert much larger than the state of Connecticut, all of it off-limits to the public. This is the Nellis Air Force Range and the Department of Energy's Nevada Test Site. Area 51, named after the grid it occupies on an old map, is located within this forbidden region. It came into existence in 1955 when Lockheed landed there to test the U-2, a high-altitude surveillance plane. The top-secret base later became a proving ground for successive generations of high-tech prototypes, including the F-117A Stealth fighter. For the first 34 years of its existence, local miners and ranchers tolerated their mysterious neighbor. Sonic booms rattled the valleys daily, and some nights people would look up and see strange, fluttering lights or oddly shaped aircraft. Most of the phenomena could be explained. Some, however, could not—especially the hovering points of light that, in an eye-blink, shifted position in the sky.

Shortly after the Travises purchased the inn, a self-described physicist named Bob Lazar shattered Rachel's placid existence. Lazar claimed that he had worked at a facility south of Area 51 on a project to "reverse engineer" one of nine captured alien flying saucers held there, dismantling it to see how it worked. Lazar's story got big play on a Las Vegas television station. Much of it didn't check out, but word of Lazar's intriguing assertion spread quickly, drawing ever-growing numbers of the inquisitive, confused and downright alien-addled to Rachel. "I remember thinking at the time that we were a business," Pat Travis says, "and whether we believed in aliens or not, God had put this opportunity in our laps. It was ours to use."

The Travises added seven rooms to their establishment for overnight guests. They also rechristened the place the Little A'Le'Inn. Within a few years, Nevada designated the stretch of deserted Highway 375 fronting Rachel "The Extraterrestrial Highway," and for a while TV and movie producers became as common in town as ranchers. "On peak days," Pat says, "we get hundreds of people through here. The curious, the skeptics and a lot of people who claim they've had 'encounters.'"

Among the inn's unique visitors have been a 300-pound transvestite who believes he was abducted by aliens, and a character who purports to be an interstellar emissary from the planet Draconis. He calls himself Merlyn Merlin II. "I've had commercial airline pilots come in and tell me they've seen UFO's," Pat says. "Most of them don't report it because of the hassles they'd get. But they want to talk about it. So that's what we do here: allow people to come and talk freely, and listen."

The inn sponsors twice-yearly symposiums attended by everyone from serious UFO scholars to less reliable thinkers. There's also an annual "Walk to the Boundary," during which hundreds of people hike up to the unambiguous signs delineating the Nellis property line. They read: "Warning. Restricted Area," and one even cautions "Use of Deadly Force Authorized."

The Travises maintain a good-natured open-mindedness about what they hear, but they've had some inexplicable moments of their own. "My niece and I saw a saucer-shaped light moving erratically in the sky several weeks ago," Pat tells me. "And about a month ago, Joe and I were driving back from Vegas, and I saw this round object, like a circle of translucent light, moving along the side of the highway. I said to Joe, 'Did you see that?' And he said, 'Yeah, but I thought I was imagining it.'"

Joe points to the inn's back door. "That door is solid steel. It's facing the sunset right now, and no light from the sun is getting inside, right? But a few years back, we were sitting here and a cylinder of light about three inches across shot through the steel and then stopped—it *stopped*—about six feet into the room. It illuminated the doorjamb in blue. We both witnessed it, and we've never found anyone who could explain it."

I look around the room. Near that back door, a wall is plastered with photographic images of what are said to be aliens and flying saucers. My favorite shows a cowboy pouring a can of beer down a horse's throat as a saucer streaks through the sky. I start to order the house specialty, the Alien Burger, then have second thoughts. "Don't worry," Pat reassures me. "It's made out of beef."

*Donovan Webster wrote recently about the Underground Railroad, pipe organs and the Yellowstone to Yukon wildlife corridor.*

PETER MENZEL

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SMITHSONIAN HIGHLIGHTS

On the off chance that something could go wrong, National Museum of Natural History officials waited last September until the crowds had left. Thus it was that a lone group of museum staff anxiously watched as that majestic specimen of *Loxodonta africanus* was moved into a new place in the rotunda. Taking every precaution, the rigging crew eased it up and over so that another platform could be built around it. The completed display, in which the beloved pachyderm appears as if running across an Angolan landscape at the start of the rainy season, amid sounds of insects and animals, gives new life to an old friend. —*Beth Py-Lieberman*

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SMITHSONIAN HIGHLIGHTS

## These Rare Lands

**SMITHSONIAN INSTITUTION TRAVELING EXHIBITION SERVICE**

The clouds zipped across the sky on the windy day when photographer Stan Jorstad hiked out to capture El Capitan, in Guadalupe Mountains National Park, on film. "Even if I could have stopped them [with the speed of the camera] I don't think I would have," recalls Jorstad. That feeling of motion in the sky is one of the many experiences that the photographer shares with his viewers in an upcoming Smithsonian traveling exhibition that demonstrates his intimate knowledge of the nation's 55 national parks. The show opens on January 15 at the Maui Arts and Cultural Center in Kahului, Hawaii. Sponsored by sporting goods retailer Galyan's, "These Rare Lands" presents 42 large-format panoramic photographs, on loan from Time Inc., that capture the majesty of America's open spaces. Throughout the year the Smithsonian sends about 40 different traveling shows to communities beyond Washington, D.C. Visit the SITES Webpage www.si.edu/sites to find an art, science or humanities exhibition coming to a museum, library, science center, historical society, aquarium, community center or school near you.

## Renovations Begin

**OLD PATENT OFFICE BUILDING CLOSES**

January 3 is the last day for visitors at the National Museum of American Art, and six days later the National Portrait Gallery will also close its doors. For the next three years, the museums' historic home, the Old Patent Office Building, will undergo a major renovation. Praised by Walt Whitman as the "noblest of Washington buildings," it is considered one of the finest examples of Greek Revival architecture in the country. During the Civil War the building served as a hospital for wounded Union soldiers, a temporary barracks and a morgue. In March 1865, it was the site of Abraham Lincoln's second inaugural ball. The planned $60 million renovation will be the first in more than 30 years. A portion of both museums' collections, including masterworks from NMAA and the Presidential portraits from NPG, will travel in several exhibitions scheduled for cities across the United States.

## Smithsonian Website

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Visit our homepage and click on

STAN JORSTAD/TIME; P. 32 CHIP CLARK/PHOTO ARCHIVES, NATIONAL MUSEUM OF NATURAL HISTORY, SI

Stan Jorstad's panoramic image of Guadalupe Mountains National Park is in a SITES exhibition in Hawaii.

"Events" to see more of Stan Jorstad's images. The on-line calendar is designed so that visitors can view online versions of these exhibitions, as well as the Websites of all the Smithsonian museums.

## Exhibitions and Events

### ANACOSTIA MUSEUM

All galleries will be closed for renovation until spring of 2001.

### NATIONAL MUSEUM OF AFRICAN ART

*A Concrete Vision: Oshogbo Art: The Early Years* (January 23 through October 22) Features works from participants in a 1960s artistic renaissance that developed in the western Nigerian town of Oshogbo.

### ARTS AND INDUSTRIES BUILDING

*The Artistry of Orchids* (January 22 through March 26) Specially designed gardens, hanging from walls and trees and filled with hundreds of orchids

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MOTHER NATURE and Father Time do most of the work aging Jack Daniel's. We just check in on them occasionally.

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A celebration of the orchid family opens in the Arts and Industries Building.

from the collections of the Smithsonian's Horticulture Services Division and the U.S. Botanic Garden, plus paintings, drawings, sculptures, jewelry, photographs and illustrations, all to celebrate the family Orchidaceae.

### RENWICK GALLERY (NMAA)

*Glass! Glorious Glass!* (through January 30) Reveals the range of techniques in this medium.

### NATIONAL MUSEUM OF AMERICAN HISTORY

*Make the Dirt Fly! Building the Panama Canal* (through January 5, 2001) A Smithsonian Institution Libraries exhibition on the heroic, ten-year engineering project.

*On Time* A new permanent exhibition exploring the changing ways that Americans have measured, used and thought about time over the past 300 years.

*Preserving the Star-Spangled Banner: The Flag that Inspired the National Anthem* Visitors are invited to observe the conservation process.

### NATIONAL MUSEUM OF NATURAL HISTORY

*African Voices* A new permanent exhibition examines the diversity, dynamism and global influence of Africa's peoples.

*In Place of Prairie* (through March 7) Award-winning photographer Terry Evans explores the diversity of prairies and the people who settled them.

### NATIONAL AIR AND SPACE MUSEUM

*Breitling Orbiter 3* The gondola of the first balloon to travel nonstop around the world is on permanent display.

### HIRSHHORN MUSEUM AND SCULPTURE GARDEN

*Regarding Beauty: A View of the Late Twentieth Century* (through January 17) Explores the age-old concept of beauty and its contemporary interpretation.

*Directions—Shahzia Sikander* (through February 21) Some 30 works on paper and a mural by the American-based Pakistani artist.

KAREN MILES/SMITHSONIAN HORTICULTURE SERVICES DIVISION


# A Tale of Two Bookstores

Jane wanted to buy books for her holiday gift shopping. She went to the megastore and found staff who thought David Copperfield was a magician.

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### NATIONAL POSTAL MUSEUM

*Missing You: Last Letters from World War II* (through April 30) Letters sent home before the writers were killed in action.

*Posted Aboard R.M.S. Titanic* (through June 12) Artifacts recovered at sea memorialize five sea post clerks who died when the great ship sank.

### ARTHUR M. SACKLER GALLERY

*Antoin Sevruguin and the Persian Image* (through May 28) Sevruguin's photographs record Iran's culture.

*Constructing Identities: Recent Works by Jananne al-Ani* (through February 28) Photographs and a slide projection show challenge the stereotype of the "Oriental" female.

*Imaging the Word: Selections of Calligraphy from the Islamic World* (through May 7) The museum's collection from the 9th to the 20th century.

### FREER GALLERY OF ART

*Masterpieces of Chinese Painting* (through January 30) Some of the great works for which the Freer Gallery has become known worldwide.

### GEORGE GUSTAV HEYE CENTER
[NEW YORK CITY]

*Instrument of Change: Jim Schoppert Retrospective, 1947-1992* (through February 6) Works from the Alaskan artist.

## Planning a Smithsonian Visit?

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Begin your visit at the Associates' Reception Desk in the Castle's Smithsonian Information Center—open 9 A.M.-4 P.M. daily. (Please note, however, that the Castle and the Commons Restaurant will be closed January 10-14.) Learn what's new at the Smithsonian and about other area attractions—with brochures, videos, touch screens, electronic maps and more. Smithsonian museums are generally open 10 A.M.-5:30 P.M. daily, except December 25. To receive a free Associates' planning packet, write to Smithsonian Information, Smithsonian Institution, Washington, D.C. 20560-0010, or send your request via e-mail to info@info.si.edu, or call 202-357-2700 (voice) or 202-357-1729 (TTY), 9 A.M.-5 P.M., Monday-Friday; 10 A.M.-4 P.M., Saturday-Sunday. Note: Parking on the Mall is limited; Metrorail is convenient to most museums.

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These finished chips, each about a half-inch across, have not yet been cut apart. Opposite: Workers don their "bunny suits" before entering clean rooms.

# Making the Chips that Run the World

**A PIECE OF CAKE: PUT 9½ MILLION TRANSISTORS IN A SPACE THE SIZE OF YOUR THUMBNAIL AND ALLOW ZERO CONTAMINATION**

**BY JAKE PAGE**

**PHOTOGRAPHS BY KAY CHERNUSH**

LIKE UNCOUNTED MILLIONS OF PEOPLE in the world, I have Intel inside. It says so right in front of me on a silvery sticker glued to my laptop.

But I also have Intel *outside*.

Two miles west and a bit south of my house as the crow flies, looming on the edge of a high sandy mesa overlooking the Rio Grande in New Mexico, is a 218-acre installation that includes three Intel fabrication plants, or Fabs. Up there they make the microprocessors, the chips that run the show, that Intel has inside laptops like mine.

All I knew about any of this until recently was that microprocessors, the very core of our computers, are so complicated that they defy common understanding. I also knew from the local media that the newest Intel Fab in New Mexico was a huge room the size of about five football fields, and it cost more than $4,000 a square foot.

I got curious about such extremes of scale and, having talked my way inside, I soon had my first hands-on experience of the magic of this new engine powering the global village. I assisted in constructing a chip from variously colored bits of Play-Doh. Yes, kindergarten is in store for newbies at Intel. It is called a Functional Area Macro Overview Class or, in a place just as ebulliently awash in acronyms as the Department of Defense, a FAM.

Among my classmates was Terry McDer-

If all goes well, each silicon atom will line up in the proper position, creating a single crystal.

mott, a linebacker-size gent with twinkly eyes who was once a local TV sportscaster and, prior to that, a catcher and infielder in the Los Angeles Dodgers organization. Now one of his chores in life is to shepherd people like me through the Intel chip-making labyrinth.

From the FAM, I learned first that chips, none any larger than my thumbnail, may be made of some 20 infinitesimally thin layers, and that they are produced on wafers of silicon eight inches in diameter, with anywhere from 100 to 600 chips to a wafer. When the industry began in 1960, the wafers were about the same size as communion wafers, hence the name. Think of a wafer as a pizza, Terry said, in a more secular vein. The bigger the pizza, the more pepperoni you can get on it. And of course, the smaller the pepperoni slices, the more you can get on it, too. Smaller is better: cheaper and faster.

We were slow. It took the better part of two hours for us to make the first few layers of a chip with our Play-Doh, cutting out shapes with stencils they call masks, placing them carefully one upon the prior one, making little holes through several layers like elevators between floors so the layers could communicate with each other. During the process, we were interrupted by Intel's musical cue over a loudspeaker that meant it was time for everyone to stop whatever they were doing and begin five to ten minutes of stretching exercises. They really mean everybody, whether you're a technician in the Fab or a "carpetdweller" (office worker) in a cubicle.

Life in an Intel Fab begins and ends with these wafers, now 8 inches but before long 12 inches (more room for pepperoni). The wafers arrive at the plant in cassettes of 25 and months later go forth much altered but still in cassettes of 25. The wafers are made of almost pure silicon, the second most plentiful element in the earth's crust and what is known as a semiconductor: it can easily be persuaded to be a conductor or an insulator, which means that it can conduct electricity or not. Each transistor that will be built into the finished chip is an electrical switch that can be on or off. A positive charge fed into a transistor's gate opens it, in a sense, and a negative charge closes it. In the many layers of a Pentium III chip they can install as many as 9½ million transistors.

A bit shell-shocked by so many zeros, I naively asked where the wafers came from and soon enough found myself at the approximate beginnings of the entire chip-making flow in one of the plants that grows silicon crystals and makes wafers out of them—a place in Phoenix, Arizona, called Sumitomo Sitix.

Silicon arrives at Sitix in a form so pure that only one atom of impurity is permitted in ten billion atoms of silicon. In an atmosphere of inert argon gas, the silicon is melted at 2,700 degrees Fahrenheit in disposable $2,000 crucibles placed in a soldierly row of large blue ovens. Boron atoms are added to increase its electrical conductivity. Into this broth, a needlelike apparatus lowers a tiny silicon seed crystal, which is then pulled ever so slowly upward as it revolves. If all goes well in the next 72 hours, as the silicon freezes onto the crystal, each silicon atom will line up in the proper position, creating a huge single silicon crystal four feet long that looks for all the world like a 250-pound chromium-plated salami.

The giant cylindrical crystals are then robotically hauled off to be ground down to the proper diameter (eight inches), x-rayed, and given thermal and other stresses to simulate whatever conditions the customer may later subject them to. Then they are whisked off, again automatically, to be sawed into chunks and then wafers by what Sitix chief operating officer Robert Gill likens to a giant bread slicer. The saw consists of high-tension steel wires, each about the thickness of a human hair, wrapped around three drums, taut as the rows of wire in a piano. The "blades" move back and forth, dragging a mix of oil and Carborundum through the silicon crystal, and in seven hours the big crystal chunks have been neatly sliced into wafers, 1/32 of an inch thick.

A crystal forming from molten silicon is slowly drawn from the furnace in which it was heated to 2,700 degrees F. At right, Rosemary Gerald checks the temperature of a finished crystal while Gary Burgess works the furnace controls.

A major criterion for a wafer is that it be flat, so that electrons will have uniform pathways to follow. On average, its elevation does not vary more than one micron—1/25,000 of an inch (a human hair is about 100 microns in diameter). Bob Gill explained the

These rooms are the most fanatically clean, most thoroughly sanitized on the planet.

degree of accuracy this way: suppose instead of an eight-inch wafer you have a road grader and you are told to grade a circular area that is two miles in diameter. The terrain cannot vary in elevation from one place to another by more than two-thirds of an inch.

Back in micronland, it takes a lot of grinding, polishing, heating and cleaning to achieve this sort of tolerance. All of this is done without the touch of the human hand, the hand being far too gross an implement for this kind of work. Within glassed-in stations, little metal arms thrust forward and pull backward like the beaks of mechanical herons, feeding wafers into each successive operation while other mechanical arms seem to be saluting with Prussian precision. After each process, the wafers move along in special cassettes that are often kept submerged in water, the better to protect their surfaces from unwanted intrusions.

A big container of wafers in water is very heavy, and a robot that looks like a high-tech laundry bin bustles along a track, picking them up and depositing them at their next station. The robot (which has evidently been sexed and is referred to in the third person as "he") plays the Beatles' "Let It Be," one of 1,001 songs in his repertoire, to warn of his approach. If a visitor unwittingly stands in his track, he will stop a few inches away and politely ask the interloper to get out of the way.

Thousands of readings are taken for each wafer, to monitor thickness, bow, warp, taper and flatness. The wafers are cleaned chemically and mechanically, visually inspected under exceedingly bright lights—a particle half a micron across on the highly polished surface will light up like a beacon—and reinspected by laser for particles that are only two-tenths of a micron. The wafers are sorted into four bins: "reclean," "repolish," "scrap" or "good." Selected good ones are then rechecked by x-ray, atomic absorption spectrograph and scanning electron microscope for the likes of unwanted ions and metals. Those judged pristine go forth (in special shipping boxes, of course) to the places where microprocessors and other chips are made.

The most crucial steps in wafer making (that is, the trickiest steps) are growing the giant crystals and polishing the wafers, but if there is a higher power in all this, cleanliness is right next to it. Much of wafer-making takes place in what are called clean rooms. Such rooms are even more important to the actual making of microprocessors on these wafers, so we will interrupt the product flow here to rehearse the precise nature of the most fanatically clean, most thoroughly sanitized places on the planet.

Technically speaking, they are called laminar flow clean rooms, and they were invented by Sandia National Laboratories in Albuquerque, New Mexico, happily at just about the time they came to be required for making microprocessors. Laminar flow means that particles of a fluid or gas all move in parallel tiers or rows, and in this case it means that the air in a clean room all moves continuously from the ceiling down to the floor, where it vanishes through grates. Then it flows through large fans back into the room via the ceiling, which is made up of a huge array of filters. In this manner, all the air in a given room can be changed at least six times a minute—even in a Fab the size of five football fields. (By comparison, the average home air-conditioning system changes the air in a house about twice a day.) In a clean room, the flowing air carries away with it all the nasty stuff that most air and most rooms are filled with, a process aided by the fact that the air pressure inside is greater than that outside, keeping most dirty air from entering in the first place.

**Wafer slices from a cylindrical crystal wait in quartz "boats" to be examined for defects.**

A cubic foot of the air you are currently breathing likely contains several hundred grains of pollen and fungal spores, as well as carbon monoxide, radon gas, scent molecules, spider legs, fragments of soil, fur, a bit of carbon from a faraway fire, dust mites from your carpet, flakes of your skin, hair, lint, bacteria and viruses and 15-micron-wide droplets from when you sneezed (SMITHSONIAN, April 1995). In all, that cubic foot of air typically contains about a million specks half a micron or larger of one thing or another (ten million if there's a smoker present), any one of which could wreck a microprocessor.

Intel's Fab 11 is a Class One

John Hallam places wafers in a machine that will polish them to extraordinarily close tolerances.

clean room, meaning among other things that anything more than one half-micron particle in a cubic foot of air is strictly verboten, but in practice Intel folk take beady-eyed notice if the sensors located all over the place note any particles at all.

To understand why chips require such extraordinary degrees of cleanliness, think of a chip in terms of the Manhattan metaphor. To wit: imagine a detailed map of Manhattan, with every street, every alley, showing. Then reduce that map down to a piece of paper a quarter-inch by a quarter-inch. If you stuck a pin in the map now, it would create a pothole from Times Square practically to Harlem. One obvious result is that traffic would come to an everlasting halt. Even a mere flake of Godzilla skin would short out the entire city by lying across four or five north-south avenues.

So how do clean rooms cope with us slovenly types? Clothes, they like to say, by Omar the Tentmaker.

Or in other words, the "bunny suit." Intel "employees" in multicolored bunny suits danced on the TV screen in whimsical company ads not long ago. Subsequently, many real Intel employees requested pastel bunny suits—each costs about $800—but they only have white.

It took me about 15 minutes, with a lot of instruction and patient assistance, to put on a bunny suit. (I had been told that I wasn't allowed to wear any makeup, hair spray, gel, perfume or aftershave.) The outfit includes blue booties over the shoes, like those worn by the cast of *ER*. A floppy snoodlike affair over the hair, and another one around the lower face for those with facial hair. Soft white gloves. A helmet with a hood to be rigged with two PVC-type pipes fixed inside near the opening for the face and extruding out the back of the hood. Donning of the actual suit (which opens at the top) involves inserting the feet first and then the arms. I note as I sit on a bench struggling into the suit that the regulars can do the whole procedure standing up.

Cinch a belt around the waist, and then put on the helmet. The hood needs to be stuffed under the shoulders of the suit, and the suit zipped up across the shoulders. A

**Workers monitor furnaces in which a layer of silicon dioxide is added to wafers. "Guns" read bar codes on the boats.**

clear plastic spit shield is affixed over the lower part of the face opening. Then the pipes from the helmet are attached to an air-filtration system in a box that hooks onto the belt, along with a battery pack. The pipes begin sucking exhalations away amid a slightly breathy hum. Then I put on more booties, which reach almost to the knees and fasten tightly around the legs with snaps. Finally, yellow latex gloves carefully tucked under the cuffs of the suit go on and a pair of clear plastic safety glasses. At this point, bundled up like a birthday present and standing in the steady room temperature of 72 degrees F, I wished I had worn something cooler, such as a pair of shorts and a T-shirt, like most clean room employees.

On first entering a Fab, a newbie will be forgiven for imagining he or she has entered a 21st-century James Bond movie. The vastly large structure is broken up into long corridors and shorter cross-corridors. It is here that newly arrived pure silicon wafers will undergo a process not completely unlike what the FAM did with Play-Doh. I knew that much, of course, but the Fab had an eerie look. It is mostly white, though down some corridors one sees areas lit by a lemony yellow light. The floors are all made of grating for the air circulation. Here and there, rods about two feet long with little cylindrical nubbins on the end hang down from the high ceiling, looking like devices to listen in for sedition. Also overhead, plastic boxes filled with wafers zip around silently on tracks, veering off into one or another cross-corridor where people in white bunny suits, standing alone or in small groups, are desultorily watching large and mostly motionless machines behind glass. It's as if, on some command by a titanically ambitious Dr. No, the place will suddenly burst into action and the world will abruptly end. But no . . .

Ann Tiao, whose title is Inline Defect Engineer and who

acted as our guide, explained that the little bugs hanging from the ceiling are "ionizers." In the course of being worked on by all the machines, the chips-to-be (called dice, plural of "die") collect ions, and a buildup of negative or positive ions could lead to an electrostatic discharge that would in turn blow apart circuits on the dice. So the ionizers pump great quantities of both positive and negative ions into the superclean air to neutralize any ion buildup on any surface.

The bunny-suited troops, Tiao assured me, were in fact extremely busy monitoring the behavior of the "tools," the huge machines that accomplish one or another process along the flow and that, at a cost of some $5 million apiece, give new meaning to that humble term. And these multimillion-dollar tools can misbehave, it seems. A technician's job is to know the idiosyncrasies of his or her tool and make the proper adjustments when it strays. So there is craft here, too, and artisanship.

Tiao led us around to each of the tools needed to make a layer of transistors on a wafer. The entire process is, of course, based on a design drawn up long before, a complicated three-dimensional map of a microprocessor.

Part of the process is not unlike lithography, the means of printing by which this magazine is produced. In the Fab this stage is called "litho," and its numerous steps take place in those areas bathed in yellow light. On top of an insulating layer of silicon dioxide, the wafer is coated with a substance called photoresist. A stencil is placed over the photoresist layer and is exposed to ultraviolet light (UV).

Individual memory chips that have been found defective are marked with a black dot and will be discarded.

The portions of photoresist that are struck by the UV become soluble and are washed away, leaving a photoresist pattern on top of the silicon dioxide. Each chip on a wafer is exposed in this manner, and from there the wafer goes to a scanning electron microscope, where a technician makes sure the patterns are the right width and that everything is properly aligned. If not, the wafer will be stripped down to the insulating layer and redone.

It's as if the place will suddenly burst into action and the world will abruptly end.

From here, the wafers are shuttled off to have the circuits etched so they become vertical-sided channels only a quarter-micron across. Etching can be a bit messy, however, creating particles and such, so the wafers go immediately to be cleaned in sulfuric acid, which removes the remaining photoresist and any particles. The acid is then rinsed off by water so pure it becomes an even stronger solvent than it naturally is.

After this step (and virtually all the others) the wafers are subjected to an optical inspection to detect imperfections that can be fixed—practical when a few dice are involved but not in a "white out," in which many are spoiled. It is far better to junk a spoiled wafer earlier rather than later, since each step is expensive. Even with the astounding economies of scale involved in producing millions of these little chips a week, those that are microprocessors will represent more than 10 percent of the cost of a personal computer.

The litho and etch processes are repeated again and again. Thus, a chip is built up of layers of different materials, using different patterns. If a layer is too thick, or if electricity can't be sent through it, the chip is tossed. The final test is called "sort." A tool with needlelike probes taps test points on each chip's surface—10,000 taps, or tests, a second. Any chip that fails any of the tests is adorned with a drop of ink, the Black Spot, the stigma of shame, meaning, of course, doom.

The tour over, Terry McDermott and I followed Tiao down a quarter-mile-long corridor like a couple of tired ballplayers headed for the showers. We shed our bunny suits and were taken in hand by Bill Westmoreland, site environmental manager. He insisted that we go through what is called the Subfab, the place where

Moore's Law states that the number of transistors on each chip will double every year.

80 percent of the working part of the tools reside. It is really the basement, but unlike any basement I had ever imagined.

In the Subfab of Fab 11, one could eat one's oatmeal off the floor. It is a vast, high-ceilinged place with no loose wires drooping, no dark spiderwebbed corners, no leaking pipes or dank spots where the sump pump fails to function. Here instead is the place where there are surely more miles of overhead pipes, tubes and lines than anywhere else on earth. Each of these thousands upon thousands of conduits is labeled so one can tell which chemical or gas or what voltage it is carrying to the tools upstairs or out of the Fab. Here is a place packed with giant compressors, chillers, heaters, a single pipeline that is well over six feet in diameter, and gigantic, looming scrubbers.

A plant like this has the potential for an enormous environmental impact. In an arid land, it uses four million gallons of water a day—as much as nine of Albuquerque's golf courses. But 85 percent of the water is eventually discharged to the Rio Grande. Acids and bases are neutralized. The nasty part of hydrofluoric acid, for example, is precipitated out into inert calcium fluoride "cakes."

Many people whose job it is to see that the machines do their work never see what happens next to their handiwork—the tasks of cutting the chips from each wafer and "packaging" them. In the so-called packaging process, diamond-blade saws cut out each individual chip from the wafers, and each one is glued with a thermal-cure adhesive onto a square plastic or ceramic substrate anywhere from 0.6 to 1.4 inches across. Looking at a chip now attached to a green plastic square put me in mind of looking down on a tennis stadium, with the chip perhaps as center court.

To see how it's done, I went to an Intel development lab in Chandler, Arizona, where a new chip design called for a lot of tinkering with the tools. It was a smaller, faster chip—produced, I assumed, in accordance with what the semiconductor industry calls, in tones of awe, Moore's Law. Moore's Law is named for Gordon Moore, one of the original brains behind Intel. His law, enunciated in the 1960s, states that the number of transistors on a chip will double every year.

For the new chip, some 500 gold wires—the electrical leads—had to be attached to the chip and then to the substrate in three layers, a task done by an astonishingly complex and fast-moving "sewing machine" according to a carefully worked out maplike blueprint fed into the sewing machine's brain. The process is called thermal sonic bonding. The gold thread is $1\frac{1}{5}$ mils thick (one mil is 1/1,000 inch), or one-seventh the thickness of the average human hair. The sewing machine (technically, a wire-bonding machine) forms a tiny gold ball on the end of the thread, taps it onto the proper aluminum spot on the chip and bonds it there with a blast of ultrasound. It then draws the wire over to the plastic substrate and repeats the process. It will place from four to seven such leads per second, a frantic business indeed when peered at through a microscope.

**At Intel's Chandler, Arizona, facility, Jonathan McFarland operates a press that encapsulates chips with an epoxy compound to protect them from the environment.**

The chip and its filigree of gold are too fragile to be left

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|---|---|---|---|---|---|
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| *40* | $ 123 | $ 158 | $ 185 | $ 238 | $ 260 |
| *45* | $ 190 | $ 215 | $ 253 | $ 330 | $ 385 |
| *50* | $ 253 | $ 290 | $ 363 | $ 490 | $ 495 |
| *55* | $ 360 | $ 413 | $ 550 | $ 835 | $ 1,015 |
| *60* | $ 503 | $ 608 | $ 845 | $ 2,135 | $ 2,400 |
| *65* | $ 775 | $ 975 | $1,593 | $ 3,900 | $ 3,900 |
| *70* | $1,338 | $ 1,600 | $2,970 | $ 7,220 | $ 7,220 |
| *75* | $2,275 | $ 4,870 | $5,820 | $10,440 | $12,420 |

### *Male Premiums*

| Age | 10 YEAR | 15 YEAR | 20 YEAR | 25 YEAR | 30 YEAR |
|---|---|---|---|---|---|
| *35* | $ 123 | $ 138 | $ 165 | $ 223 | $ 253 |
| *40* | $ 148 | $ 183 | $ 225 | $ 288 | $ 335 |
| *45* | $ 225 | $ 300 | $ 360 | $ 450 | $ 513 |
| *50* | $ 338 | $ 455 | $ 525 | $ 730 | $ 828 |
| *55* | $ 500 | $ 670 | $ 768 | $ 1,638 | $ 2,330 |
| *60* | $ 783 | $ 990 | $1,265 | $ 3,630 | $ 3,630 |
| *65* | $1,330 | $ 1,650 | $2,693 | $ 5,250 | $ 5,250 |
| *70* | $2,448 | $ 3,175 | $4,860 | $ 8,790 | $ 8,790 |
| *75* | $4,400 | $ 7,443 | $9,600 | $13,260 | $15,030 |

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At Intel, stretching sessions are scheduled twice during every 12-hour shift, in addition to the three breaks allowed.

unprotected. The whole thing is covered over with an epoxy seal, never to see the light again. Its destiny is to be placed on a circuit board and shipped off to somewhere in the world where it might be put inside a laptop like mine with a silvery label affixed that says "Intel Inside."

Later on, I asked Gordon Moore, Intel chairman emeritus, if there was really much need for chips with exponentially more transistors, more power, more speed. He said, "Think of a personal computer that recognized your face, your voice, and understood well enough to know if you were saying 'too,' 'to,' or 'two.' That would take a lot more power. It's maybe two generations away." In Silicon Valley-speak, two generations is about four years. There will always be a need for greater power and speed, Moore added. The software programmers can always use it. "We have a saying: Intel giveth and Microsoft taketh away."

Asked how he had come up with Moore's Law, he said that it was very early in the semiconductor industry and many people didn't recognize the industry's possibilities. He simply wanted to startle the world into seeing its importance, so he announced the doubling law. With a beatific smile, he said modestly that he was surprised and delighted to find that it had, in fact, worked out that way.

*Jake Page reported on a unique ranchers' group on the Mexico-New Mexico-Arizona border in June 1997. In the past 19 years, Kay Chernush has photographed everything from gems to toxic waste.*

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# *Moving* BIG Stuff

IF YOU CAN
MOVE A
LIGHTHOUSE,
YOU CAN
MOVE
ANYTHING

BY WENDY MITMAN CLARKE

YOU WOULD THINK that a 198-foot-tall, 129-year-old lighthouse, perched upon a fleet of hydraulic jacks and squat dollies conveying it gently along a steel-track runway, would at least have the decency to groan a little. Wouldn't you? Gotta be, I think to myself, and lower my ears as close as I dare to one of the outboard dollies.

Workers are scuttling all around and underneath the structure as it inches along, checking hydraulic lines and the dollies' alignment, but I haven't the nerve to go down there. The thing does weigh 4,830 tons, after all. That's 9.7 million pounds, in case your calculator is not handy. So I just lean over, close my eyes and try to blank out the din of trucks, generators and compressors all around, and listen only for the old lighthouse's voice.

What has it to say about all this hoopla?

Zip. Nada. Nothing. The dollies occasionally emit a small squeak, like air escaping the pinched neck of a balloon, and once or twice I hear one creak a little. Shavings of soap, rubbed on the tracks to slick the runway, curl off the steel until the dollies have passed and squished them flatter than road pizza. That's it. Here we are at what's being called "the move of the millennium," and the movee—the Cape Hatteras Lighthouse—seems impervious to all the com-

En route from its original site (above) to a new one 2,900 feet away, the historic Cape Hatteras Lighthouse encounters a droll crossing sign.

motion. After withstanding more than a century of the Atlantic maelstrom without budging, the gleaming, candy-striped tower silently inches 2,900 feet to its new home safely back from the eroding North Carolina beach. And that's just exactly how Jerry Matyiko, the prime mover of the moment, wants it.

One of Matyiko's ham-hock hands is firmly clamped around a radio and a badly gnawed cigar. His other hand is never far from the bank of levers and dials arrayed across a six-foot-tall red console, control central for the 100 hydraulic jacks keeping the lighthouse on an even keel. On top of the console is a computer monitor, linked to a sensor system, that shows the vertical alignment of the lighthouse. A red ring represents the top of the light, a blue ring its base. It goes without saying that keeping the red ring centered within the blue ring is right up there with breathing on Matyiko's "to do" list.

Matyiko is president of Expert House Movers in Sharptown, Maryland, which is doing the actual moving of the lighthouse. International Chimney Company of Buffalo, New York, is overseeing the entire project. The two companies have worked together for several years moving ungodly tall and delicate stuff—skinny, brick-lined chimneys, historic theaters and three lighthouses in New England. But this lighthouse is the ungodliest tall and most delicate of all, a symbol of the country's maritime past so evocative that people come here from all over the country to risk a stroke climbing its 257 steps, just to stand up there, gasping for breath, staring out across a limitless sea.

It has taken decades to reach this point, as engineers studied the best ways to protect the light from the ocean's steady encroachment. Debate waxed and waned over whether it could be moved or even should be moved. Finally, Congress gave the National Park Service, which operates Cape Hatteras National Seashore and oversees the light, the go-ahead and $12 million. The first job was to sever the lighthouse from its foundation. Using a heavy-duty saw with a diamond-encrusted cable as the blade, workers sliced through the granite like they were cutting a giant Bundt cake in half horizontally. Then came the lifting.

Think about putting your '57 Chevy up on blocks: first you jack up one corner and wedge a big block of oak under there to hold that corner up, then you follow suit with the other three corners. In a nutshell, that's what International Chimney did. As workers cut the foundation, they chipped away at the granite underneath, break-

PP. 48, 49 MIKE BOOHER/NPS (2)

Suspended between two enormous steel beams, a 200-ton autoclave is hauled through Pico Rivera, California, in the dead of night. The moving rig has 112 tires.

CHAD SLATTERY

ing off two-foot sections at a time and filling the gap with steel shoring towers resembling four-foot-square, upside-down milk crates. Once the entire lighthouse rested on those towers, workers slid seven steel beams between them. Each was equipped with built-in hydraulic jacks piggybacked on small, steel-rollered dollies that would become the lighthouse's feet for the move. Then 15 cross beams were threaded at 90-degree angles with the seven main beams. This framework, which would serve as the lighthouse's temporary foundation, comprised about 400 tons of steel. All the while, dump truck after dump truck unloaded some 10,000 tons of stone, which was graded and compacted to level the lighthouse's path.

Then came the first real move—a vertical one. Painstakingly, over a week, the lighthouse was jacked up about six feet so it would be level with the runway. To give the dollies something to roll on, seven "travel beams" were inserted beneath them, forming seven long steel tracks. Right in front of them on the roadway, workers laid down a huge steel mat like a giant red carpet, then extended the steel tracks onto the mat. This was the lighthouse's runway; a mass of steel and bolts, it would be dismantled after the light passed over it, then carried to the front and laid down again in a giant game of leapfrog. And what did the actual pushing? Five hydraulic rams, four named after the Matyiko brothers—Jerry, Jim, John and Joe—and one called Mr. Pete F., for Peter Friesen, Expert's consulting engineer and moving guru.

Thousands of people have been coming here each day to see the lighthouse crawling along. Elderly women in broad-brimmed hats delicately pick their way through the flora, while fathers wielding camcorders troop through with babies slung on their backs. It takes about 45 seconds to a minute for the rams to push the lighthouse five feet, the extent of their throw. Then there's a pause of about five minutes as the system recharges, like the slow breathing of some mechanical giant. Exhale. Inhale. Exhale. Inhale. At every exhalation, someone in the crowd yells, "It's moving! It's moving!"

Welcome to the world of big moves, where the question, "Can it be done?" is answered with meticulous hours of engineering, months of planning, gobs of money, frequent all-nighters, saintly patience and no small dose of ego. Whether it's a historic lighthouse, a paddle wheeler, a chunk of rocket, a nuclear reactor, the torch for the Statue of Liberty, the thermal containment shield for the Three

Mile Island nuclear plant or a fiberglass whale for Sea World, it can be moved. There's a huge difference in engineering, planning and logistics between moving a seemingly immovable object like the Cape Hatteras Lighthouse a few thousand feet behind a row of sand dunes, and rigging a giant piece of machinery on a specially designed and built trailer and trucking it a thousand miles.

But both share the same basic problem: a need to get from point A to point B. For either, the red tape is intimidating. Remember how much you love going to the motor vehicles department to get your license renewed after accidentally letting it expire? Magnify that about a thousand times. To obtain permits for a fairly complex interstate move may take months, since every state, municipality and utility company affected gets involved. The logistics are mind-boggling. Only about six companies in the entire country are capable of handling colossal moves like these, and the more complicated and challenging they are, the more these guys like it. "A lot of this is the excitement of taking it on," says Terry Emmert, owner of Emmert International, headquartered in Clackamas, Oregon. "When someone says, 'You can't do it, we've never issued a permit for anything that big,' those are the ones you want to do."

*The question, "Can it be done?" is answered with hours of engineering, months of planning, gobs of money and no small dose of ego.*

Emmert, who also owns a few athletic clubs as well as an interest in a local weekly newspaper, and serves as finance chairman for the Oregon Republican Party, exudes bigness—big ego, big smile, big outlook, big swagger, big gold watch on his wrist. It seems appropriate that he's built a successful company from scratch moving big stuff. About 30 percent of Emmert International's business is moving buildings, and the rest is moving "superloads," generally defined as anything really, really big, either in dimension or weight. While buildings usually don't move very far, superloads can move thousands of miles across the country, through cities and towns and over all kinds of difficult terrain.

In 1992, Emmert moved the HK-1 Flying Boat, better known as the Spruce Goose. First, the historic plane, built in 1947 by Howard Hughes, was shipped from Long Beach, California, to Oregon via ocean barge. Emmert transferred it to river barges and ferried it up the Willamette River. Trucks then carried the plane on a seven-mile overland route to its new home, a museum in McMinnville. The fuselage alone is 185 feet long and weighs 286,000 pounds. The wings are 158 feet long and 62 feet wide, each sandwiched within a steel framework. The tail towered nine stories above the road. Moved on hydraulic, rubber-wheeled dollies, the fuselage, wrapped in white

**Heavy-haul project manager Chris Johnson (top) adjusts one of the thick slings supporting the autoclave. Changing tires on the rig (above) is a formidable task.**

CHAD SLATTERY (3)

**A night owl watches the autoclave pass a brightly lit gas station. Such big moves usually take place at night, so they're off the road when morning traffic begins.**

plastic, loomed over telephone poles and treetops, emerging from banks of evergreens like some kind of alien ship.

No doubt about it, the Spruce Goose was, in industry parlance, "a big move." But Terry Emmert's personal favorite remains the 70-year-old Fairmount Hotel in San Antonio, Texas. The six-block journey in 1985 took four days and involved lifting the three-story building from its foundation onto a bed of 36 rubber-wheeled hydraulic dollies. Each dolly could be turned individually or in tandem, enabling the hotel to negotiate 110-degree and 90-degree turns, one of which took six hours. Using five trucks loaded with gravel as anchors—each weighing about 50,000 pounds—the Fairmount was winched along the route by a huge crane. When it came to the Market Street bridge across the San Antonio River, Las Vegas oddsmakers gave 7-to-1 that the hotel never would make it to the other side. Workers reinforced the bridge, and as a warning device Emmert wedged three bottles of beer (a Lone Star, a Coors and a Bud) into a gap between the bridge deck and a ledge beneath. If the bottles broke, it meant the bridge was sagging too much. The beer made it through unscathed, as did the bridge and the hotel.

The move earned Emmert a spot in the *Guinness Book of World Records* in 1986 for the largest building ever moved on rubber wheels. But records—especially in the world of monumental moves—are made to be broken. In 1997, International Chimney and Expert House Movers teamed up and borrowed equipment from companies all around the country to set a new one, hauling the Gem Theater in Detroit, a fragile brick structure dating in part to the 1920s, nearly 2,000 feet to make way for the new Detroit Lions and Tigers stadium complex. They followed that last spring by relocating the 76-by-82-foot Shubert Theater a quarter-mile through downtown Minneapolis.

Baseball fans have nothing on these guys when it comes to statistics. Any mover can rattle off his or her biggest move by engineering hours, fabrication hours, routing hours, permitting hours, man-hours, gross vehicle weight, length, width, height, distance traveled and, most important, whether it snagged them any records or awards. At the Specialized Riggers and Carriers Association's 1999 Oversize/Overweight Transportation Symposium in St. Louis, seminars on such topics as "Trunnion Axle and Tridem Axle Efficiencies: Is There a Broad Difference?"

A tugboat conveys sections of Howard Hughes' Spruce Goose by barge from Long Beach, California, to Oregon in 1992.

weren't nearly as well attended as the schmoozes after hours, where attendees one-upped each other between the stuffed mushrooms and fajitas with stories of ugly moves, funny moves, wild moves and hair-raising moves.

IT'S AROUND 11 O'CLOCK ON A SUNDAY NIGHT, AND a nearly full August moon shines high above a vacant parking lot in an industrial section of Pico Rivera, an extremely un-Brentwood suburb of Los Angeles. The rumble of diesel trucks is like low background music, and somewhere nearby a killdeer can be heard. Chris Johnson, heavy-haul project manager for Intermountain Rigging and HeavyHaul, gathers his crew around him for one last detail and safety check. Their night's work is to get a 200-ton autoclave moved through Pico Rivera and as far down the road as possible before daybreak, when they must pull off the road for the day. ("The biggest thing with something like this," Johnson says, "is finding a parking spot.") The $4.5 million autoclave—a big, dirty-yellow cylinder with what looks like a fat nipple on one end—has been used at this Northrop Grumman plant to build composite parts for the B2 bomber. Now it's being transported about 800 miles to Hill Air Force Base in Ogden, Utah, where it will resume its work.

The autoclave is more or less slung from two overhead beams held up by two sets of wheel carriages, one at each end of the beams. It can be raised and lowered about three feet to dip beneath low bridges or skate over high bumps or crossings in the road. Altogether, this rig has 14 axles, each with 8 tires. The forward-most carriage has two axles and can be hydraulically manipulated. Both it and the rear-end carriage are independently controlled, which enables the rig to practically turn around within its own length. Two trucks—one to push and one to pull—propel the rig. A 20,000-pound chunk of concrete rests on the back of the rear truck for better traction. This contraption is nearly 20 feet high, 21 feet wide and not quite the length of a football field.

Johnson thinks it will take 15 days to travel the 750 miles to the company's facility in Salt Lake City, where the rig will wait a week before continuing another 50 miles to Ogden. The entourage includes Johnson's Ford F250, four or five state highway patrol cars, local police, a bucket truck to lift telephone, cable and power wires, pilot cars fore and aft, and a variety of support vehicles.

There's very little that's glamorous about this move—it's going to be a long, dark, slow night, and the only people watching will be a few lonely hearts, insomniacs or hardcore barflies who will want to reexamine the bottoms of their mugs when they see what's passing by the window. No calls to *Guinness* after this one. But these are the kinds of superloads that happen all over the country, all the time. Without them, you'd be surprised how your life would be affected. Generators, boilers and turbines for electric plants, parts of refineries, containment vessels for gas and nuclear plants, transformers for electrical substations—without this stuff being where it is and doing what it does, you probably couldn't flick on your lights every evening or enjoy a hot shower in the morning.

The toughest part about moving the autoclave to Utah will be this first night. The rig must snake through an urban area, cross numerous intersections—at times taking up four lanes of roadway—and negotiate a couple of 90-degree turns, complicated by hills, traffic lights, median curbs and rails. And the very first one, wouldn't you know, is the right turn out of this Northrop Grumman parking lot onto Paramount Boulevard.

As the rig starts to creep into the intersection, Johnson folds his tall frame into a compact squat, watching the bottom of the autoclave dip ever closer to the slope in the road. When it starts scraping, he speaks into his collar-mounted radio to one of his crew, telling him to raise the autoclave to clear the street. Driver Dave Ostberg eases the rig forward again. The autoclave swings and squeaks slightly. It starts roughing up a hedge of oleander flanking the parking lot's chain-link fence, and the beams from

CHAD SLATTERY

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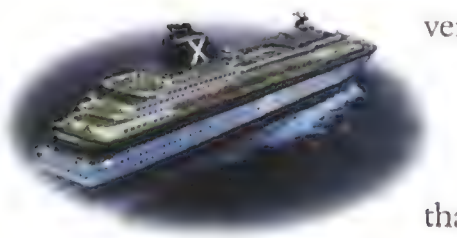

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which it's suspended are threatening to make origami of a traffic light on the corner.

Meanwhile, Ostberg has to maneuver the front of his truck past another traffic light in the middle of the intersection. It isn't going to make it. Everything stops, and some men use a sledgehammer to whack out the pin coupling the rear of the rig to the push truck. They disengage the push truck, then back up the whole rig a few feet, and have another go at the intersection.

Johnson is striding back and forth, back and forth, checking this and that and muttering into his radio. He never raises his voice; look up "laconic" in the dictionary and there's probably a picture of him. On the aft hydraulic carriage, 22-year-old Mike Hyde is another cool customer, one hand holding a cigarette, the other wrapped around the box that houses the controls. As Ostberg works the front of the rig, Hyde maneuvers the back independently, trying again to make the turn. It takes four tries, inching forward and back, forward and back. At one point, the rig's rear wheels are pointed straight across the intersection, while the front is 90 degrees the other way, pointed down the street. The whole thing looks like a snake with indigestion. Finally, the rig eases through the intersection and onto the street. It has taken 45 minutes to move the first 150 feet. Only 799 miles, 5,130 feet to go.

The first turns are often the worst, Johnson says. He's not too perturbed. "Let's see how we do here," he says. We're in his truck, approaching the corner of Paramount and Washington. At the AM-PM Mart on one corner, several onlookers stand slack-jawed, Twinkies akimbo, as this giant slowly rolls through the intersection with just a moment's halt to raise the autoclave a fraction to clear the median strip. "Well, that was a little better corner, huh?" Johnson says into his radio.

"Yup," answers Ostberg.

And so it goes. Dipping beneath power lines, poling others up in the air, removing and replacing traffic signs, trying not to crack the whip on turns (when the man controlling the back end can't steer fast enough to keep up with the front end), all night long. It's easy to get lulled, but dangerous. As we're ducking under some electrical wires, Ostberg tells about a trip he did when the wire man misjudged the height and the wires touched the rig. "We blew five tires off the trailer," he says. "That's scary."

Johnson tells another story about a 450,000-pound locomotive that Intermountain was hired to lift and move from Salt Lake City to Ogden. Every time they tried to start lifting the engine, it kept trying to fall over.

"Turns out that 30 years earlier they had abandoned it full of fuel. They just sealed it up and left it there," Johnson says. Some 3,000 gallons of diesel fuel had turned to tar and settled toward one side of the engine. It took a week to liquefy the fuel and pump it out, then start all over again. The move itself took only an anticlimactic six hours. "You may have all the blueprints in the world," Johnson says. "There's still an element of surprise."

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MIKE BOOHER/NPS

Then there was the phone call that came in one night to Bert Lundell, who at the time was the director of the office that grants permits for oversize moves in Texas. The caller was an irate member of the Waxahachie Jaycees who was furious because a superload had just rolled through town, catching all the group's Christmas lights as it went. "I said, 'Well, did you have them 16 feet up?' [the state-regulated height for low-voltage wires]. He said, 'Sixteen feet! No one will see them.' I think it was a premanufactured house that snagged them. It became very well decorated for the season."

Back at Cape Hatteras, I ask Dan McClarren, the National Park Service's supervisor for the lighthouse move, whether he's had any Maalox moments. "Yesterday," he says bluntly, and describes a harrowing few hours when the computer system that keeps the movers apprised of the lighthouse's equilibrium started acting like it had gotten into Uncle Milt's liquor cupboard. For one thing, the red circle depicting the top of the light was in the monitor's upper right-hand corner instead of in the center of the blue circle representing its base, essentially showing the lighthouse tipping over. Meantime, surveyors using robotic surveying instruments insisted everything was OK.

"When you're relying on the computer and the surveyors tell you something else, things get tense real quick," McClarren says. "I thought Jerry [Matyiko] was going to take that computer and throw it in the ocean yesterday." Work stopped for half the day as everyone tried to figure out just what the heck was going on, but not before erroneous adjustments were made that actually did tilt the top of the lighthouse 2½ feet off center. Once it was determined that the surveyors were right and the computer was having a bad day, it only took a few moments to bring the lighthouse back into alignment, with no harm done except for a few fierce cases of indigestion.

*On July 9, 1999, the Cape Hatteras Lighthouse rolled to a final stop at its new home, 23 days after its journey began.*

Eleven days later, at 1:23 P.M., on July 9, 1999, the Cape Hatteras Lighthouse rolled to a final stop at its new home, 23 days after its journey had begun. In the middle of August the last of the shoring towers were removed. Restoring the granite plinth stones around its base and rebuilding the steps into the tower would continue for two more months, but the move of the millennium was over. Sitting on the beach nearby, where the ocean has pounded for centuries and the lonely lighthouse still keeps watch over all, I couldn't help wondering: What will the super movers move next?

*Wendy Mitman Clarke is senior editor at* Chesapeake Bay Magazine *in Annapolis, Maryland. In March 1995, she wrote about the BOC Challenge, a solo round-the-world sailing race.*

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BY BENNETT SCHIFF

# Martin Johnson Heade: An American Original

**A MASTER OF LIGHT, ATMOSPHERE AND MOOD, THE 19TH-CENTURY ARTIST IS NOW RECOGNIZED AS ONE OF THIS COUNTRY'S GREAT ROMANTIC PAINTERS**

A pair of tiny birds is engulfed in a tropical maze of exotic blossoms and sinuous vines in *Passion Flowers and Hummingbirds* (detail), c. 1870-83. Heade began painting these complex compositions after his third and last trip to Latin America.

Heade's dramatic *Thunder Storm on Narragansett Bay* (1868), with its contrasting palette of lights and darks, led to the painter's rediscovery.

PP. 62, 63 MUSEUM OF FINE ARTS, BOSTON

ON A RARE DAY IN 1944, THE WELL-RESPECTED ART DEALER ROBERT G. MCINTYRE, WHO WAS presumed, for very good reasons, to know a great deal about 19th-century American art, went to the exhibition "Romantic Painting in America" at the Museum of Modern Art in New York City. There he saw an astonishing picture by an artist whose work he did not know. The small canvas, *Thunder Storm on Narragansett Bay*, painted in 1868, dealt McIntyre a stunning emotional blow, as if a bolt of lightning had suddenly jumped from the wall.

"I was struck with the force of the thing," he later wrote, "with the powerful drama being

AMON CARTER MUSEUM, FORT WORTH

enacted—a sort of cosmic catastrophe fraught with a breath-taking sense of elemental fury; or it might be a concluding phase of human existence, the prelude to a new chapter."

The shock was hardly momentary. McIntyre became so engrossed in the painting and what he subsequently learned about the artist, Martin Johnson Heade, that he went on to become the painter's first biographer. McIntyre's description of his initial experience of Heade's work is detailed in chapter one of the biography, which was published in 1948, four years after that pivotal encounter.

There is another intriguing track into the gradual reemergence, now blooming into full flower, of this accomplished American artist. It begins with the art historian Theodore E. Stebbins, Jr., chair of the Art of the Americas department at the Museum of Fine Arts, Boston. Stebbins, who published a definitive work on Heade in 1975, has written a completely new monograph—including a meticulous catalogue raisonné—due out from Yale University Press early this year.

Stebbins first became aware of Heade some 35 years ago when he was a graduate student at Harvard University's Fogg Art Museum. As he relates in the preface to his 1975 study, "I was first introduced to the work of Martin Johnson Heade in the spring of 1965 when Stuart Cary Welch of the Fogg . . . told me he had found two impressive landscapes by an American painter at the Vose Galleries in Boston, and asked whether I would like to go and see them. We went together and found that the pictures were by Heade, who was unknown to both of us; he bought one, and I the other . . . and I have been studying Heade ever since."

Now, Stebbins' work has inspired the most comprehensive exhibition of Heade's art ever mounted—only the second full-scale retrospective the artist has ever been granted. On view at the Museum of Fine Arts, Boston, through January 17, the show will continue on to Washington's National Gallery of Art, where it will be on display from February 13 through May 7, and end its tour at the Los Angeles County Museum of Art, from May 28 through August 17. The exhibition reveals, in some 75 works, the full range of this idiosyncratic artist's mastery. Included are seascapes and landscapes, paintings of hummingbirds and the tropics, and portraits of flowers, for they are more that than they are still lifes.

Together they represent, according to Stebbins, perhaps the most varied body of work by any 19th-century American painter—the culmination of

In *April Showers* (1868), stippled color and loose brushwork obscure the details; here, the subject is color, light and changing weather.

MUSEUM OF FINE ARTS, BOSTON

a career that stretched for 65 years, during which the artist seems never to have put down his brush.

Heade had shown his work frequently during his lifetime, but he had never become an artist of the first rank as these things are measured by scholars, critics, curators and collectors—the cultural establishment. He was still at his easel a few weeks before he died in 1904, but his reputation had already been eclipsed by a shroud of critical indifference.

For nearly half a century it was as if Heade had never painted a picture. Except, that is, in hundreds of homes and antique stores, where there was evidence, though seldom seen and rarely recognized, of his particular genius. Stebbins' catalogue raisonné lists 621 Heades, and three more have been found since the project was completed. In early 1999—Heade's reputation by then revived—the Mu-

seum of Fine Arts in Houston paid $1.25 million for what is recognized to be a masterpiece of its kind, a portrait of magnolias on a bed of golden velvet. For years the painting had been used to cover a hole in the wall of a house in Indiana.

The Heade resurrection began with the landmark Museum of Modern Art show 57 years ago. McIntyre was not the only one who was impressed with Heade's work. Critics also took notice, and the standard histories of American art were soon revised to make room for the painter.

The breakthrough had come inauspiciously enough earlier that same year, when an antiques and art dealer called Frederick Mont found a painting he liked in an antiques store on the Boston Post Road in Larchmont, New York. He took it around to the businessman and collector Ernest Rosenfeld, who bought it on the spot.

In his voluptuous, highly realistic *Magnoliae Grandiflorae* (1888), Heade conveys the beauty, sensuality and mystery of the lush blossoms.

The picture was then brought to the attention of Dorothy Miller, the curator at the Museum of Modern Art who was putting together the Romantic painting show. That painting was the masterwork *Thunder Storm on Narragansett Bay*.

The Boston collector Maxim Karolik was also impressed by the painting and began an assiduous search for Heade's work. Over the years Karolik purchased about 50 paintings, some 30 of which he eventually gave to the Boston museum, making it the main center in the country for Heade studies.

Over the past 25 years Heade has received critical attention and acclaim from that very body of the cultural establishment that had for so long been virtually unaware of him. "Recent critics and collectors have found his work compelling in its originality," writes Stebbins in the catalogue that accompanies the exhibition; "we are fascinated by the ways it relates to yet differs from the paintings of his contemporaries. . . . Today we admire the subtlety of his atmospheric effects, the glory of his light, the sumptuous warmth of the orchids and tropical scenes, and the inexplicable sensuality of so many of his works in every genre. Above all, to our eyes Heade's work seems wonderfully rich in its handling, its iconography, its originality, and its meaning."

Heade was born into a prosperous farming family in Lumberville, Pennsylvania, in 1819. He grew up roaming the land, hunting and fishing, learning to love nature. He was to remain an ardent amateur naturalist all his life. His boyhood was apparently the only period he looked back upon with pleasure, commenting that "there has been but little of my life that I wish to repeat."

Exactly what made him decide to become an artist is unknown, but the decision made, he took lessons from a neighbor, the noted sign painter and folk artist Edward Hicks. Hicks, a Quaker preacher, is known today for the numerous versions he painted of *The Peaceable Kingdom*, a vision inspired by the Book of Isaiah.

Heade started by painting stiff, crude, nonacademic portraits. There was certainly no evidence at the time of the remarkable artist he was to become. But in 1841 he began his professional career with the display of a portrait at the annual exhibition of the Pennsylvania Academy of the Fine Arts in Philadelphia.

Two years later he left the family farm and moved to New York City. For the next 15 years he lived an itinerant life, crossing the continent and traveling abroad, all the while painting portraits, genre scenes and copies of pictures in galleries and museums wherever he went. By 1846 he was in Washington, D.C., where he did a fine portrait of Gen. Sam Houston, the hero of the Battle of San Jacinto.

For two years (1848-49), supported by a generous father, Heade traveled

COLLECTION OF JO ANN AND JULIAN GANZ, JR.

in Europe. Once back in the United States he continued his odyssey, painting in St. Louis, Chicago, Trenton, Providence, Mobile and New Orleans, turning out competent works, but nothing outstanding.

It was only in the mid-1850s that Heade became interested in landscape painting. In the summer of 1857 he went to sketch in the White Mountains of New Hampshire. That trip marked the beginning of a shift to an entirely different plane of creativity.

By that time Heade had moved from place to place for 14 years. A loner with a hard-edged attitude, he was an inveterate skeptic and frequently disparaged the wealthy, although there are records of his trying his hand at land speculation, albeit without success. Not much is known of his personal life during that time. He did not write about himself, much less about his art. He did, however, write poetry, and, later, numerous letters-to-the-editor and articles commenting on politics, wildlife and the preservation of the natural landscape for such publications as *Forest and Stream*. In any event, in 1858 he moved once more to New York City, and to a particular place in the city that fundamentally changed his life.

*In 1858 he moved to New York City, to a particular place that changed his life.*

For an artist interested in landscape painting, he could not have found a better place in which to work than the now-famous Tenth Street Studio Building in the heart of Greenwich Village. Designed by the architect Richard Morris Hunt, the building was the center for the leading painters of the Hudson River School. Frederic Church, as famous then as a rock star today, was working there, as was Sanford Gifford. Albert Bierstadt, John LaFarge and Winslow Homer also had studios in the building at different times. Nearby were John F. Kensett and Asher B. Durand.

Heade admired Church's work and the two became friends. Before long Heade gave up portraits and genre studies for landscapes and still lifes, which he pursued with characteristic intensity. The change in his technique also seemed to be miraculous. Stebbins attributes the change to Church's influence, although Heade, unlike so many other painters of the time, did not attempt to imitate the master.

What Heade derived from Church were technical ways of using newly developed pigments and an expanded vision of the natural world. Church's predominance was supreme at the time. His vast paintings of Niagara Falls and the mountainous landscapes of the Andes were the age's counterparts in the public imagination of today's cinematic spectacles.

It took about a year or so after Heade began to work in the Tenth Street building for him to fully develop his distinctly personal style. But by 1859 he was already producing his first seascapes, including the masterpiece *Approaching Thunder Storm*. And

MANOOGIAN COLLECTION

**Based on his studies in Brazil, Heade painted *Blue Morpho Butterfly*, c. 1864-65.**

Rays of sunlight break through a gray sky in *Newburyport Meadows* (c. 1875). Heade painted more than 120 views of salt marshes.

it was at this time that he began to paint the first of a series of Northeastern salt-marsh paintings that are perhaps his finest achievement—more than 120 known scenes unlike anything done before, or since, in American or European art.

Essentially, in his maritime and marsh paintings, Heade was a composer of mood, atmosphere and design. In *Approaching Thunder Storm*, for example, the mood is contemplative, watchful, still. An entrancing hush envelops the entire canvas.

If you spend some time looking quietly at the marsh paintings, you will take away with you something that can almost be described as spiritual. These pictures are composed, it seems, from just about where you are standing, so that you feel confronted with the scene as if you were standing in Heade's footprints.

Heade plays with light. Sometimes it comes from the surface of the painting itself and sometimes from outside, from somewhere in back of your shoulders. What makes some of his work surreal is that at times it comes from both places at once in the same picture. And, in the midst of this, there is almost always some detail, a sail, a figure, that is highlighted as if by a shaft of brilliant sunlight.

There is a structural tension in these paintings; they are so harmoniously balanced, so taut, that you feel that if a leaf were to drop, or a branch fall into the water, the picture would shatter. They become, before your eyes, a distillation of sensation—poetry visualized.

For incandescent beauty the marsh paintings can compare with anything done in the 19th century. They are not in the least overshadowed, as different as the technique and the concept may be, by Monet's haystack series, for instance. Marshes were dotted with haystacks, too, and Heade's, in their decidedly individualistic

METROPOLITAN MUSEUM OF ART

way, are no less remarkable than the French Impressionist's.

In his 1868 *April Showers*, which may well be one of the freshest, prettiest works in all of 19th-century American painting, Heade is still preoccupied with color, light and changes in weather, but his brushwork is markedly looser. Stebbins calls the painting "an extraordinary precursor to the impressionist style," but goes on to say that after attempting a few related works in 1874, Heade "never again returned to the subject of the flowering apple tree or to anything like a nascent impressionist style."

Heade was to make three trips to Latin America between 1863 and 1870. The first was to Brazil to paint hummingbirds. He was fascinated by the tiny birds and in later life, in Florida, he and his wife were to keep them as pets. In a notebook now in the Archives of American Art, Heade marveled at the attractiveness of the birds for anyone who is "in the least degree attuned to poetic feeling." He had planned, in fact, to publish a book of chromolithographs of hummingbirds to be called *The Gems of Brazil*, much as Audubon had issued his monumental *Birds of America*, but the project never came to fruition.

After traveling in 1870 to Colombia, Panama and Jamaica, Heade began his series of paintings of hummingbirds and tropical flowers. These works are lush, rich in color and detail. Visually magnetizing, they turn proportion upside down, magnifying a tiny bird and an exotic flower to comparatively immense dimensions in a landscape that should, by rights, miniaturize them. The effect is pure tropical theater.

In 1883, at age 64, Heade married Elizabeth Smith of New York. He had bought a house earlier that year in St. Augustine, Florida, his first permanent home, and he took his bride there to live. From all accounts it was a warm and engaging relationship that lasted for the rest of his life.

In Florida, Heade found his first patron, Henry Morrison Flagler, a partner of John D. Rockefeller's in the Standard Oil Company. Flagler built the palatial Hotel Ponce de León and included a number of artist's studios, one of which was used by Heade.

In this Southern setting, Heade embarked on an entirely new series of paintings—the extraordinarily sensuous still lifes of magnolias that are so admired today. These superb works came to reside, in the years in which they were painted, in the homes of tourists who wanted a keepsake of their Florida travels.

During his lifetime, Heade was never recognized as the superb artist he clearly was—the full equal of the finest painters of the 19th century. This quiet exhibition of abiding beauty finally puts things right. But while his reputation is now firmly established, Heade remains an elusive personality, a ghostly figure in one of his marshland paintings.

He was, after all, a man who liked to sit quietly in his garden in later years, watching hummingbirds.

*Contributing editor Bennett Schiff wrote on the art of Egypt's Old Kingdom in September 1999.*

# Jeu de paume, anyone?

BY RUDOLPH CHELMINSKI

Pete Sampras and the Williams sisters play tennis. The author and his fancy French friends prefer its noble ancestor

PHOTOGRAPHS BY MICHAEL FREEMAN

Rudolph Chelminski (above, left) and pal Yves Carlier play doubles near the famed "horseshoe" staircase (right) at Fontainebleau.

"JUST THINK!" CRIED MY FRIEND YVES, WHO CALLS HIMSELF a count (and I believe him). "Right here in Fontainebleau we've got the oldest indoor tennis court in the world, and the biggest! You must come play." How could I possibly refuse an invitation like that? My checkered career as a foreign correspondent based in France had already exposed me to many strange and puzzling experiences. But being invited to the biggest tennis court in the world was something new. Until then, I had assumed that all tennis courts were the same size. I was wrong.

There is tennis and then there is Tennis. Pete Sampras and the redoubtable Williams sisters play one game, while my friend the count plays another one altogether—the ancestor from which the modern game derives. On the rare occasions when newspapers bother to cover this venerable sport, they refer to it adjectivally: "real" tennis in Britain, "royal" tennis in Australia, "court" tennis in the United States. But for the 3,000 or so worldwide devotees of this maddening, quirky, addictive pastime, it is simply tennis, the authentic, the original. In France, where it all began, it is still called the *jeu de paume*, the "palm game," even though rackets replaced the palm of the hand centuries ago. That's typical. You can't be afraid of anachronisms if you're a true tennis player.

I first encountered the game in one of the biggest anachronisms of all, the royal palace at Fontainebleau, a short drive from the village I now call home. This sprawling pile of limestone, brick and slate 40 miles south of Paris has been a country retreat for innumerable French kings, queens, mistresses, dauphins, emperors (the little feller with his hand inside his jacket and his nephew, Napoleon III) and assorted hangers-on ever since the 12th century. Far more ancient and interesting than Versailles, the Fontainebleau palace boasts a couple

thousand rooms, a famous "horseshoe" staircase, moats, lakes and a tennis court dating from 1601.

In the count's company, then, I ventured through the unprepossessing white door to the left of the horseshoe staircase and found myself in a tunnel-like hallway under a sharply sloping roof with what appeared to be fishnets strung along the gallery openings on the left side. On the other side of the fishnets was a huge barn of a place a little bigger than a modern lawn tennis court, with black walls and a green stone floor. Over that floor a couple of players wielding spoon-shaped wooden rackets dashed to rocket balls back and forth across a goofy net high on the sides but drooping low in the middle.

I had been expecting something genteel—old men in velvet knickers, that sort of thing—but the vociferations of the players, the pop of balls being struck and the clatter of rackets whacking against the floor created an echoing din of surprisingly passionate fury. Edging close for a better view, I got a quick lesson in the reason for the fishnets when a ball thudded into the cords at 100 miles per hour a few inches from my nose. "*Ah oui*," drawled the count. "There are rather more one-eyed players in this game than in lawn tennis."

The Fontainebleau court was built under the reign of Henri IV, a king who enjoyed his pleasures, carnal, gastronomic and *sportif* alike. It suffered its share of depredations and indignities over the centuries, but in the late 1980s the Fontainebleau mayor's office and the national Ministry of Culture had it restored to its original condition, bumpy-floored, unheated and all. And now it was time for me to play on it. Golly.

Instructed by the action I had watched, I could easily understand how the simplified modern tennis had descended from this far more complex game, a weird combination of tennis, squash and billiards. Volleys took place not just on the court floor but off all four walls, too. Unlike lawn-tennis balls, *paume* balls are handmade of cloth wrapped tightly around a cork center. They are solid, heavy and wickedly fast, and their behavior is little short of astounding.

You never know where paume balls are going. It is bedeviling enough to try to judge rebounds off the floor and carom shots off the four walls. To complicate matters further, a sloping roof, the "penthouse," borders the court on three sides, and the wall on the fourth side bulges at the far end with a protuberance called the *tam-*

During a match at Fontainebleau (opposite), a ball is served. During lunch (above), wine is served with a lavish spread.

*bour*. All this derives from the game's medieval origins, though it's not clear precisely what those origins are. There was some conjecture that monks passed the time between masses by tossing a crude cloth ball off cloister roofs. It seems more likely the shape of the court can be traced back to certain features of the buildings that lined the streets, and the penthouse from the sloping roofs of shop fronts.

The serve is delivered from one side of the court, the *dedans,* as it is called in both French and English, with the ball being rolled or bounced along the penthouse toward the receiver. After that, anything goes.

Mayhem, for instance. Clutching an upwardly bent wooden racket about two-thirds the size of Pete Sampras' and a bit heavier, I stood at the receiving end awaiting the first serve. The ball rumbled down the penthouse roof toward me, nice and slow—a piece of cake. I made ready to whip it back, right down the count's noble throat, but then it hit the wall and shot violently off to the left as I flailed at thin air. I missed it by two yards. Hey—no fair!

That was only the start. Different serves sent the ball flying in the *other* direction, or looping high over my head in seemingly unpredictable arcs, or just dribbling down to die on the floor before I could kill it myself. Such were the mysterious ways of the jeu de paume serve. After that traumatic introduction, I learned that there are at least 50 different kinds of serves, all codified and named according to their trajectories and evil intent: the *Piqué*, the Drag, the Bobble, the Caterpillar and the Giraffe are classics, while the wall-hugging Railroad and direction-changing Boomerang are guaranteed to hornswoggle all but the most experienced of players.

That first day, I discovered another law of jeu de paume physics: the balls don't like to bounce, preferring to skid as they glance off the floor, rarely rising above shin level. In perverse contradiction to this behavior, when they whang off the penthouse roof they can soar majestically high—only to spring away when they hit ground. And I learned about the tambour, too. This absurd bulge in the wall instantly changed the course of a ball struck at top speed by 90 degrees, blindsiding me with a vicious left-to-right attack—*bonk!*

Gradually, as a card-carrying member of the Cercle du Jeu de Paume de Fontainebleau, I progressed enough to recognize and anticipate many of the most wickedly intended strokes, to

deliver a few of my own and to master the more complex subtleties of the game's rules. And presently I was introduced to one of the most entertaining facts of tennis life: no one has taken to France's bent rackets and bounceless balls like the Brits.

Two things may be said of the aboriginals of the soggy island on the other side of the Channel: they have always had a thing for sports, and they have always annoyed the French. When they found out about the jeu de paume, Britons simply adopted it lock, stock and French terminology, built courts of their own and acted as if it were theirs all along. When Henry VIII's wife Anne Boleyn was arrested prior to her beheading, she was watching a game of tennis, and Shakespeare famously had Henry V and the French dauphin trading long-distance insults over a cask of tennis balls.

When the French Revolution came in 1789, it mortally wounded the game in France. The game's aristocratic reputation made it politically incorrect, not surprising at a time when the "national razor" (the guillotine) awaited many a velvet-knickered practitioner. The English, however, plowed on with the game as imperturbably as ever, and they have been its most fervent champions ever since. Of the 46-odd courts still in use around the world, 27 are in Great Britain, accounting for probably three-quarters of all the active players. Creditably, the United States has 10 courts in use (all on the East Coast) and Australia 6, but in France, where the sport was born, no more than 3 remain—workmanlike modern ones in Paris and Bordeaux, and the great monument at Fontainebleau.

**Pro Ivan Ronaldson (top) sits on a wooden horse while hand-tying balls. Rackets are made at a shop in Cambridge, England (above) .**

It was an event of some moment for the world of tennis when our renovated court was reopened in the fall of 1990. Predictably, none followed the proceedings with keener interest than the English, and Prince Edward, an enthusiastic player himself, hopped over the Channel to preside at the inauguration ceremony. Not long after that, Chris Ronaldson, the club professional at Hampton Court, made our club an offer we couldn't refuse: he would come over for a couple of months, work for free as our professional, hand-stitch our balls for us, give us lessons, assign us handicaps and generally whip us into shape, as he had already done for clubs in Australia, Scotland and England. Ronaldson is doubtless the single most respected figure in tennis today. The world champion between 1981 and 1987, he is the game's most widely acknowledged scholar and guru, and his book *A Cut Above the Rest* is the bible for tennis players and coaches alike.

So why would such an august personage bother to come to Fontainebleau, where the floor was bumpy, the facilities spartan, the air drafty, the tourists intrusive and the 30-odd members of the club fearfully ignorant of the finer points of the sport? Because the French Open was coming up, that's why. Exactly as in lawn tennis, the four major tennis tournaments of the year are the British, Australian, American and French opens. Ronaldson wanted to give it one more try before retiring from top-level competition. Since it was Fontainebleau's turn to host the open, it was clear that a few weeks of practicing at our palatial site, getting accustomed to caroms off walls, penthouse and tambour, could do no harm to his game. Alas, even the most carefully prepared professionals have knees, and Ronaldson's gave out against the younger crowd. He was eliminated in the first round.

After he returned to Hampton Court, Ronaldson made amends for his defection by dispatching his eldest son, Ivan, to be our very own, ill-paid professional. A strapping, personable six-footer, Ivan is the Mark McGwire of tennis, the hardest hitter in the game, if not always the most accurate.

Tournament followed tournament

at Fontainebleau under Ivan's stewardship, and the lad distinguished himself by winning a French championship, but his most appreciated talent proved to be rather more hedonistic: lunch. Coached by lovely Lolo, his Franco-Belgian girlfriend, Ivan quickly developed the knack of producing awesome picnic banquets for visiting teams, laying out pâtés, smoked meats and fish, galantines, baguettes, pastries, red wine and innumerable cheeses. Visiting English players, whose diet until then had consisted mainly of kippered herring, porridge and warm beer, were of course bowled over by Ivan's profusion of delights, and as word got around, the number of formal challenges to Fontainebleau's pathetic handful of tennis athletes swelled impressively.

Is there any future for this kind of tennis? Perhaps surprisingly, the answer seems to be yes. As its offspring becomes more mechanical and its professionals, like many sports stars today, become more ridiculously overpaid, a coterie of athletic purists continues to plug away at increasing the older game's appeal and bringing more young players into it. Teenagers like the American Bradley Allen and Australia's Steve Virgona could develop into the McEnroes and Samprases of the jeu de paume if they don't get wooed into some higher-paying racket. And more courts are being built. Five courts opened in 1998 and 1999 in England, another opened last year in Australia, and the United Kingdom's Tennis & Rackets Association plans several more.

Nor is America left completely in the lurch. In 1997, a new court opened in the vast Regency Sport & Health Club in McLean, Virginia, not far from the Central Intelligence Agency headquarters. The McLean installation, Prince's Court, has a stunning glass main wall behind which rows of seats can be set up, an elegant solution to tennis's old problem of where to put spectators. By the simple geometry of a game played in a pit enclosed within four high walls, it is almost impossible to squeeze more than 50 or 60 onlookers into the viewing area of classically made courts—even if it is a world championship match between top players like Steve Virgona, Mike Gooding, Julian Snow or the Australian Rob Fahey, the present title holder.

**At a new court in Northern Virginia, spectators behind a glass wall watch a *jeu de paume* match.**

One of the nice things about this game is that there are few, if any, barriers between the gods and the most egregious of fumblers. At Fontainebleau I have frequently shared our measly eight-by-eight dressing room with the world's top three players. We jeu de paume nuts are aware, of course, that Tennis will never take over from "tennis," but we cherish a little secret that all those laborious topspinners ignore: our game is a hell of a lot more fun. And our lunches are better, too.

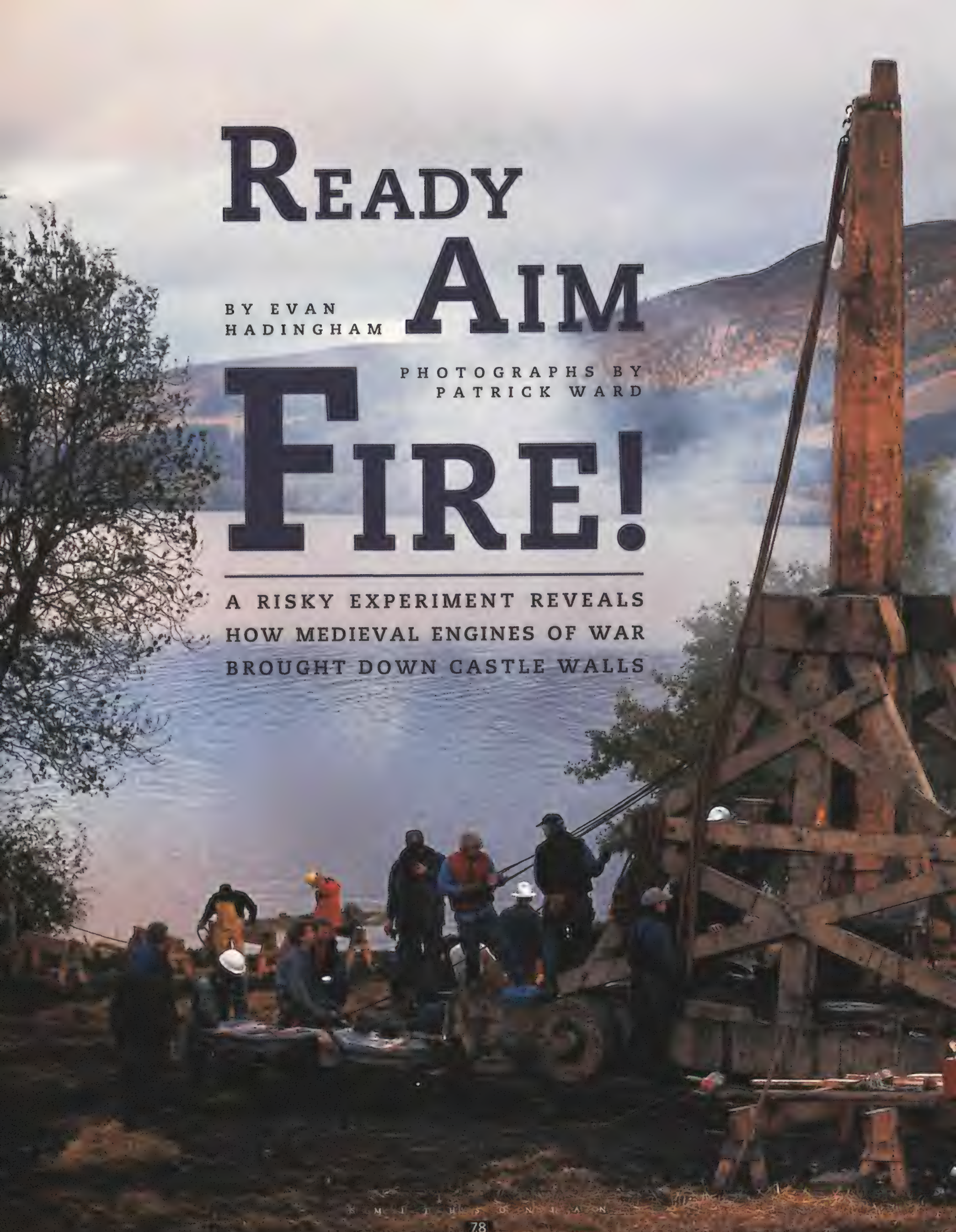
*The author last wrote for* SMITHSONIAN *about the Bosporus. Michael Freeman's pictures of Thai elephants appeared in September 1998.*

# READY AIM FIRE!

BY EVAN HADINGHAM

PHOTOGRAPHS BY PATRICK WARD

## A RISKY EXPERIMENT REVEALS HOW MEDIEVAL ENGINES OF WAR BROUGHT DOWN CASTLE WALLS



Two trebuchets are built next to Loch Ness in Scotland. In the November drizzle, a bonfire is kept going most of the time to dry out men and materials.

In a medieval image, a man at left holds the sling of a trebuchet while others—hidden by horsemen—yank ropes at the opposite end.

*The word "trebuchet" has uncertain origins. In its most primitive form, the trebuchet consisted of a pivoted beam with a sling at one end and ropes at the other.*

IN THE NOVEMBER TWILIGHT, A DANK WIND STIRS ACROSS LOCH NESS, SWEEPING A CURTAIN of penetrating drizzle toward the shore. I take my place in line and grasp a rope thickly caked with Scottish mud. Four dozen of us begin a rhythmic chant, swaying together as we haul on the twin ropes fastened to the giant wooden war machine. This is a trebuchet, a fearsome, poorly understood superweapon of the Middle Ages, which we've been constructing in a swampy field beside the loch for the past two weeks, and are about to fire for the first time.

Although the trebuchet is said to have revolutionized siege warfare eight centuries ago and to have been a potent instrument of both the Islamic and Mongol conquests, few details of its actual capabilities

GRANGER COLLECTION

and performance have survived. Medieval drawings of these gravity-powered catapults are seldom realistic; for example, the soldiers who operate them are frequently depicted as taller than the castle walls they are assaulting. And when chronicles refer to machines that fling huge stone balls and crack castle walls to their foundations, it is natural to suspect more than a hint of exaggeration. Was the trebuchet really the ultimate 13th-century deterrent many historians have supposed it to be?

At this moment such questions are academic. We're intent on hoisting one end of a 29-foot beam of Douglas fir, pivoted like an outsize teeter-totter, high into the air over our heads. It takes every muscle we've got, since the end we're raising has 6½ tons of specially cast lead ingots bolted to it. At the moment of firing, a trigger will release the beam, and the massive weight will swing toward earth, flipping the other end of the beam skyward. As that other end flies up, it will pull on a rope sling cradling a stone ball, and fling the ball in a lofty, soaring trajectory down the field.

Or so we hope. But the sight of so many tons poised above us stirs apprehension. Will our machine really hurl a 250-pound stone ball 200 yards, as it's supposed to do? Or could the ball come crashing down on our skulls instead?

The answer from the history books is not wholly encouraging. For instance, when William the Lion, king of the Scots, set up a machine to assault the English defenders of Wark Castle in 1174, the first rock tumbled feebly out of the sling and hit one of his own knights, whose armor fortunately protected him from serious harm. Others were not so lucky: a 13th-century account of the siege of Seville speaks of a rock that spun backward out of a trebuchet, killing a man.

To help forestall such mishaps we have modern engineering on our side. Our trebuchet is mostly the brainchild of Col. W. Wayne Neel, who teaches mechanical engineering at the Virginia Military Institute in Lexington, Virginia. With his pipe and tartan cap, Wayne cuts a Holmesian figure as he hovers around the machine, constantly absorbed in steely calculation and reflection.

"The way I first approached the design was not the way a 20th-century engineer would do it," Wayne explains. "Instead, I tried to take the medieval approach." Medieval craftsmen, he knew, were illiterate and had no elaborate math to guide them. Instead, they used simple whole-number ratios and geometric arcs that allowed them to plan a design and transfer it to timber using the most elementary of aids: a set of dividers, a square and a plumb bob.

After figuring out the basics, Wayne was relieved to come across an Arabic work from 1463 entitled *The Elegant Book of Trebuchets*; this work quotes ratios and proportions very similar to those he had deduced from the old drawings and his own intuition. All that was left was to ensure the safety of the design. Stepping outside the medieval world, Wayne applied standard engineering formulas to calculate the machine's bending and breaking stresses. He also crafted meticulous working scale-model trebuchets, which propel small foil-wrapped packages of butter across restaurant rooms with startling violence.

Wayne's ideas were translated into a full-sized machine as part of a *NOVA* public television miniseries on experimental archaeology. (The episode on trebuchets will air on PBS February 1.) *NOVA* flew in a team of more than 50 craftsmen, nearly all from an organization of traditional carpenters, the Timber Framers Guild of North America. *NOVA* wanted a machine that not only would replicate original trebuchet performance but as far as possible reflect the techniques of the Middle Ages.

Accordingly, a medieval craft village sprang up beside the loch. The air rang with the clanging of the blacksmith's anvil on which iron fittings for the machine were bashed

**Sandstone balls serve as ammunition. To ensure consistent test shots, they were hand-chiseled to the identical size and weight.**

out. In one corner, the "leadheads" (with modern safety masks) melted down 14,000 pounds of scrap lead for the trebuchet weights. Elsewhere, a mason patiently chiseled out ammunition, each sandstone ball identically sized so that the trebuchet would perform consistently from one shot to the next. Most curious of all, a wooden lathe was in operation; an improbable device, it was powered by a five-foot-diameter, hand-cranked wheel. The lathe operator used a sharp "lathe hog" to shave rapidly spinning pieces of wood into a desired shape. The result was an array of miraculously well-finished axles, capstans and other cylindrical wooden components.

The demands of television selected this soggy field for picturesqueness not practicality, and this complicated the timber framers' task. The track leading into the site was too steep for the delivery of timber, which had to come by barge from the loch instead. In October, it starts getting dark here by 4 P.M., and then there's the drizzle. Yet all the obstacles forged an exceptional bond between the timber framers. To a casual visitor, it looked like there was no one in charge. Communication on the site flowed quietly, almost telepathically, from one craft expert to the next: a rope adjusted here, a beam trimmed there. Under the pressures of a real siege with lives at stake, medieval carpenters must have worked with similar speed and coordination.

Casting an acerbic eye on the proceedings is Hew Kennedy, whose green Wellington boots and tweeds proclaim him a member of the landed gentry. Kennedy owns a Shropshire manor filled with armor and, more than a decade ago, was one of the first to dabble in trebuchet building. Assembling tree trunks and a 60-foot-long wooden beam, he installed his machine at the top of a sloping farm field, then began startling his neighbors by hurling drums of flaming gasoline, upright and grand pianos, dead farm animals, even a one-ton car. Although not a true replica of a medieval design, Kennedy's machine convinced him of the trebuchet's effectiveness: "If you chuck a thing that heavy at a stone wall, it will shatter it. Stone missiles are a lot more effective than upright pianos."

The word "trebuchet" has uncertain origins. The roots of the machine go back to at least the fifth century B.C. in China. In its most primitive form, it consisted of a pivoted beam with a sling at one end and ropes at the other. A stone would be placed in the sling and a team of men would haul on the ropes, swinging the beam up into the air.

Throughout the Crusades, dozens of these human-powered machines would be ranged against a castle wall, and it was said that some engines were pulled by teams of several hundred men. In retaliation, the defenders remodeled the towers with platforms broad enough to accommodate their own trebuchets. During the siege of Jerusalem in A.D. 1099, a Saracen defender was caught spying on the Crusaders' siege machinery; the unfortunate infiltrator was bound hand and foot, loaded into a catapult and hurled fatally back toward the city walls.

Finally, in the late 12th century (still well before the advent of gunpowder in the West), an unknown Islamic or Crusader engineer hit upon the idea of adding heavy weights to one end of the pivoted beam, thereby vastly multiplying the machine's potential size and destructiveness. In fact, the counterweight trebuchet was the first step in the development of large-scale mechanized warfare. When Britain's King Henry III assaulted Kenilworth Castle in 1266, he kept nine trebuchets working day and night, letting loose such a rain of destruction that stones collided in midair. The added power of the counterweight trebuchet meant that missiles could be lobbed in a high, curving arc right over the castle walls, bursting with devastating, shrapnel-like effect amidst the beleaguered defenders. The trebuchet even introduced the practice of biological warfare. At Carolstein in 1422, Lithuanian attackers shot the bodies of dead soldiers into the castle along with 2,000 cartloads of manure in a reportedly successful attempt to spread infection.

*He began startling his neighbors by hurling drums of flaming gasoline, grand pianos, dead farm animals.*

No one was more adept and ruthless at the game of siege warfare than Edward I of England (familiar to fans of the movie *Braveheart* as "Longshanks"). For three months in 1304, a mere 50 Scots held seemingly impregnable Stirling Castle under relentless attacks from Edward. The defenders had only one trebuchet, which soon broke. Ranged against them were no less than 13 machines, each sizable enough to have a pet name such as the "Vicar" or the "Parson." The royal accounts note that church roofs for miles around were stripped of lead for counterweights. Edward built a timber viewing stand for Queen Margaret and the ladies of the court from which they could watch the spectacular firing at a safe distance.

As the siege wore on, 50 of Edward's laborers toiled over the ultimate war machine, which they named the Loup de Guerre, or the "War Wolf." We have few details of this formidable weapon, but evidently the defenders, now reduced to about 30, had had enough. Their offer of surrender, however, was turned down. So eager was Edward to see the War Wolf in action that he would not

# *Handcrafting a War Machine*

Above left: Timber framers hoist the throwing arm into place. From top right: Renaud Beffeyte, left, oversees his machine, which had a hinged basket to hold the counterweight; cylindrical pieces for the machines are fashioned with a hand-cranked lathe; Col. Wayne Neel discusses design principles; lead weights are bolted onto Neel's trebuchet.

discuss terms until it was completed and had lobbed a few missiles at the castle wall.

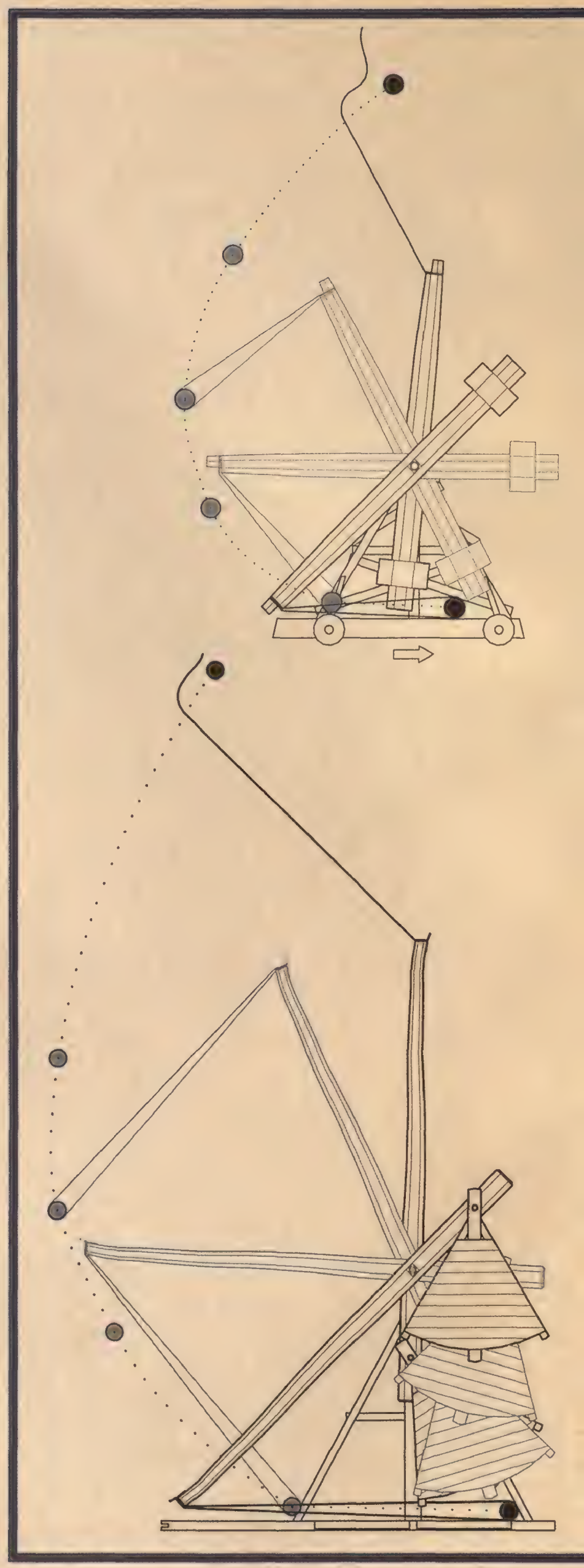
What did it take to make a machine like the War Wolf? Did the need for high-power, precision artillery give birth to a genuine science of trebuchet design? Our team beside the loch is about to find out.

One overlooked idea that we'll test is adding wheels to the base of a trebuchet, as shown in several 13th-century manuscripts. Common sense suggests that wheels would be useful merely for aiming the machine or moving it closer to castle walls. Wayne has discovered, however, that scale models without wheels often topple over after firing. Wheeled models, on the other hand, not only stay upright but actually roll forward as the weighted end of the beam swings down. This is a simple consequence of gravity, since the rolling action allows the weight to fall a straighter vertical path. It means that more energy is squeezed out of the counterweight's fall, so the missile will be flung farther. The rolling motion also has the effect of dampening forces that tend to topple the machine or shake it apart.

So this elementary design feature may well turn out to be a brilliant stroke of medieval engineering—that's if our 30-ton replica behaves identically to Wayne's models, and rolls forward on its wheels as it fires. Based on years of hurling pianos, Hew Kennedy is skeptical. "It's very difficult to hit a target wall, and wheels won't help," he asserts. "In a model it's OK if it lurches all over the place, but in a full-sized model we should tie it down."

A more fundamental argument in trebuchet design centers on the counterweight. Medieval drawings frequently show machines with a large hinged basket that rotates around the end of the beam, rather than a fixed weight. The operators filled up the basket with sand, rocks or any heavy material at hand. A comparison of the drawings suggests that hinged trebuchets mostly replaced the fixed type, so they may have possessed a hidden mechanical advantage. Wayne suspects that the swinging of the basket would give an extra "kick" to the machine and fling the projectile farther, similar to the action of wheels. An account by a 13th-century chronicler, Aegidio Colonna, seems to support Wayne's hunch. Colonna observed that hinged machines shot farther than those with fixed weights (but added a disparaging note that they also shot less accurately).

Such distinctions might be academic trifles if *NOVA*'s producer hadn't decided to spice up the program by commissioning a second trebuchet, now rising in the same swampy field alongside the first. When finished, this second contraption will feature a hinged basket and an immobile base, in contrast to the fixed lead weights and wheels of Wayne's device. And it will be the work of a designer with a very different background to Wayne's.



*As the end flies up, it will pull on a rope sling cradling a stone ball, and fling the ball in a lofty, soaring trajectory down the field.*

A trebuchet consists of a giant, pivoting beam with weights on one end and a sling to deliver a missile attached to the other. The weighted end is raised and, when the machine is fired, it falls to earth. The sling pulls the ammunition, flinging it upward with great force and releasing it at the crucial moment. Neel's siege machine (top diagram) has fixed weights and is on wheels; the weights in Beffeyte's trebuchet (bottom) are in a hinged basket.

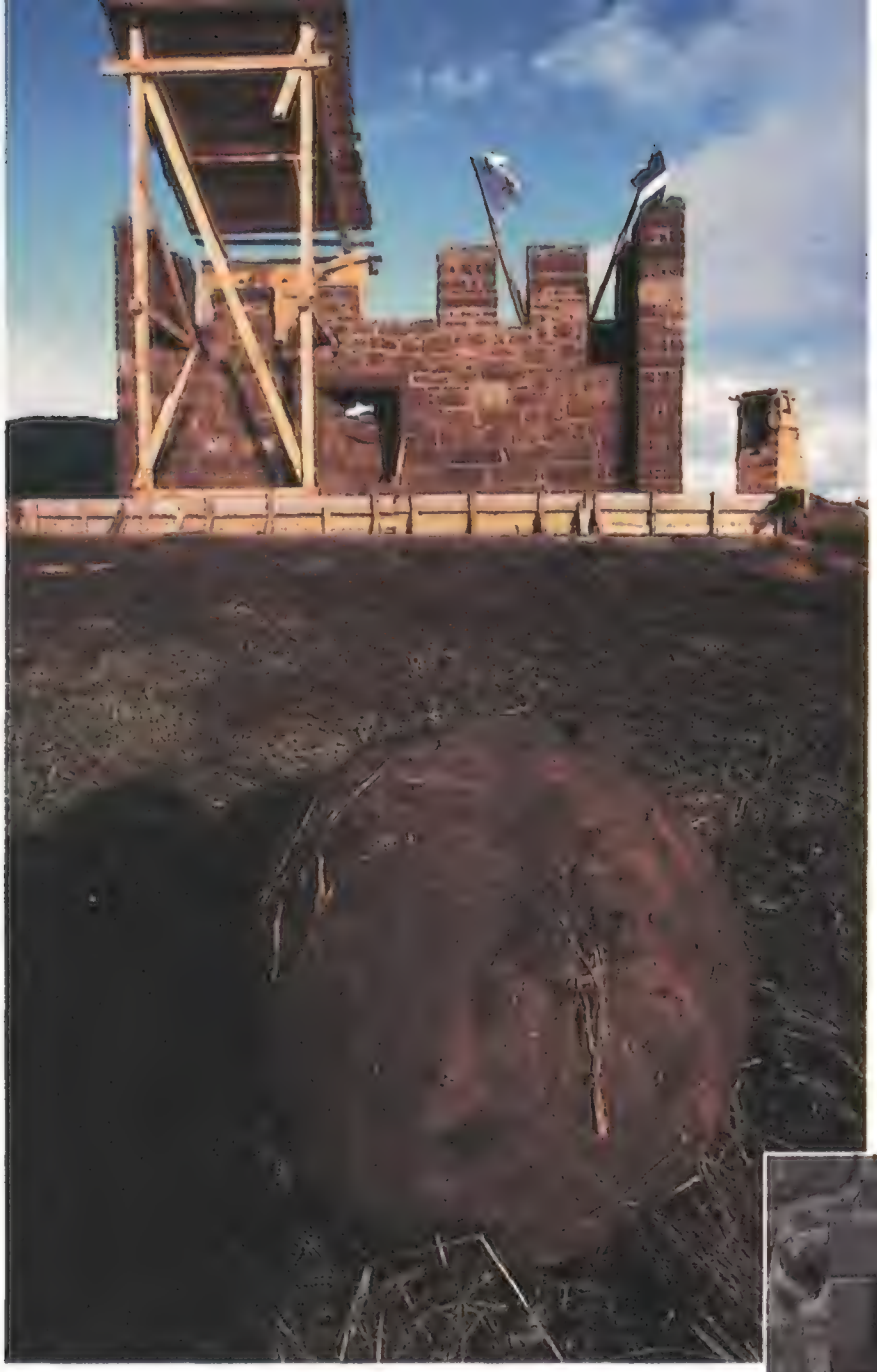
Renaud Beffeyte, a shrewd, good-humored Frenchman, is a master carpenter rather than an engineer. He is also perhaps the world's only full-time trebuchet maker, the creator of more than 30 machines for castles and museums around the world since 1984. A giant oak log has been landed by barge, and by the time the timber framers have finished trimming it, Renaud is confronted with a slender throwing arm no less than 42 feet long. This will require a trebuchet far bigger than Renaud—or anyone else since the Middle Ages—has attempted to build.

To meet the challenge, Renaud turns to the sole existing medieval "blueprint" for a trebuchet. (Unfortunately, only one fragment of the plan—the layout of the base—survives.) It fills one of 33 pages of a notebook compiled by a man named Villard de Honnecourt, who lived in northern France in the early 13th century. The notebook offers a unique glimpse of the mind of a master architect or engineer, a medieval Leonardo, although Villard's precise professional status and career are unknown. He crammed the pages of his notebook with meticulous plans of abbeys and cathedrals, designs for labor-saving gadgets and perpetual motion machines, and sketches of nudes and insects.

Renaud had long dreamed of building a trebuchet based on Villard's plan but was always intimidated by its enormous scale, since the sketch implies a machine more than five stories tall. Now, faced with the 42-foot-long throwing arm, Renaud decides that the opportunity has finally come to realize Villard's ambitious design. What began as a competition to build two rival machines quickly turns into an intense cooperative effort, as the timber framers struggle to assemble intricately fitted wooden structures.

At last, after two weeks' heroic effort, the moment of truth arrives. I find myself in line with four dozen others on the ropes, hoisting the heavy end of Wayne's throwing arm as high as it will go. Hastily the timber framers scramble to insert a long metal trigger pin into the tackle that holds the ropes fast. Now they must load the machine. The ammunition consists of a 250-pound sandstone ball, which they roll into position on a long plank set directly underneath the throwing arm. A rope sling is then carefully fastened so that it cradles the ball at one end while the other loops over a wooden prong protruding from the arm. When the trigger is pulled and the arm flies up, the sling will pull the ball off the plank and fling it upward in a high arc. At the crucial moment, one end of the sling will slip off the prong, releasing the ball.

By now I have retired to a safe distance, since standing next to our untried machine feels like sitting on a keg of gunpowder with a sizzling fuse. A dozen men get ready to pull on the rope attached to the trigger pin. Someone yells "Fire in the hole!" The men yank . . . and nothing happens.



While one shot (above) falls short of the five-foot thick target wall, another causes considerable damage (right).

The pin is stuck fast, imprisoned by friction and the three-ton load on the trigger chain. The men fumble and struggle, then suddenly the pin flies free of the tackle. There is an eerie moment as the apparatus seems to hang in suspension. Then, with a low rumble the ball slides forward, and in a surprisingly graceful motion it soars up and arcs over the machine, finally flying free of the rope at a heart-stopping 60 feet above the ground. Off it sails through the gray skies until, with a mighty thump and spatter, it finds a mark in the distant mud. A police radar gun clocks the ball's speed at 127 miles per hour.

Although the display of brute mechanical power is exhilarating, the ball has fallen short. Our machine is aiming at a specially built target wall 200 yards away; it is five feet thick at the base and modeled after the upper battlements of a medieval castle, with narrow slots for archers to shoot through. If our trebuchets are to be any good as siege engines, they must pound away reliably at a specific patch of wall, at a safe distance from defenders' arrows.

Wayne judges that the sling released the ball late, so that it flew in too flat a trajectory. Now he shortens the sling by one foot, so the ball will be released sooner and curve higher into the air, thus traveling farther up the field. For good measure, Wayne rubs a little lard on the wooden prong so that the sling will slip off the end more readily.

Feeling bolder for the second shot, I stick close to the machine and Wayne, who is thinking aloud about his engineering predictions. "The frame should roll forward around six feet," he remarks. This time, the ball is released smoothly, in a higher arc, and whizzes by the right-hand edge of the wall, missing it by inches. The timber framers yell in exultation and tear up the field in pursuit. Wayne, however, puffs on his pipe and steps coolly up to the machine with his tape measure. The entire frame has been rolling back and forth in sympathy with the swinging of the great arm, the timber groaning in protest. Now, as the machine comes to rest, Wayne bends over and measures. "A little over five feet," he mutters in satisfaction. The wheeled frame has worked much as he anticipated, adding additional force to the ball while dampening the stresses of firing.

It takes four more shots until, finally, there's a direct hit: a ball careens into the arrow slot in the middle of the wall, pulverizing the masonry and ejecting a fountain of dirt and rubble out the wall's back side. Could it be due to the kilts that the timber framers have just put on for good luck? More likely, it is thanks to Wayne's tiny adjustments to the length of the sling and the position of the frame. After a mere half-dozen shots, the machine has proved that it can fire with surprising precision and consistency.

With this satisfying result, work now redoubles on Renaud's machine. How will the absence of wheels and the different counterweight design affect its performance? When finally complete, the machine stands 54 feet tall, and its long, slender throwing arm now looks decidedly fragile. For its first shot, Renaud cautiously orders the counterweight basket to be loaded with a mere two tons of sand.

"A heavy silence descended on the work site, normally so animated," Renaud wrote afterward. "Everyone was waiting, and I was feeling the pressure. I stepped back to calm myself by taking time to contemplate 'the beast.' She was truly magnificent—powerful, balanced, of noble breed. Then I sensed a real harmony and a mounting confidence. I silently thanked my operative ancestor, Villard de Honnecourt, and his little secrets of geometry."

With too little ballast in the basket, the first ball hops feebly into the air and thumps to earth just over 100 feet away. So more sand is added while Renaud watches ner-

P. 84 ILLUSTRATION: ED LEVIN

vously to see if the arm will break. Now the machine shoots in a high, lobbing arc, much higher than the trajectory of Wayne's machine—so high, in fact, that it cannot reach the wall. Although there is only one day to go before the end of the project, Renaud's prospects look good if he can figure out a way to flatten the path of the ball.

The next day dawns despondently with snow that turns into driving rain. The ropes become mired in mud, and fingers are numb with the effort of wringing them dry. When the weather clears, Renaud tries a new strategy. The throwing arm of his machine has an iron finger on the end, in place of the wooden prong of Wayne's. With the help of a welding torch, Renaud bends the prong forward, so that the sling will slip off the end just a fraction of a second later. This does the trick, for now the shots become near misses indeed, whizzing barely inches above the top of the battlements. Renaud will score a bull's-eye if the path of the ball can be lowered by a whisker. But is such a fine adjustment possible? With a hammer, one of the timber framers taps gingerly at the base of the iron finger. He's bending it forward barely perceptibly—a couple of millimeters—when Renaud motions him to stop.

The sky grows black again with an impending storm. The ropes are stretched and frayed, the stone ball almost too greasy to roll into position. This is clearly Renaud's final chance. For the last time, the trigger flies out of the tackle and the ball rumbles down the plank. Up it goes, arching against the storm clouds over the loch, then bearing down on the battered wall. Thanks to the tiny shift in the prong, the ball's path is now two feet lower, and the missile lands with a resounding crash squarely on the top of the battlements. Masonry explodes in all directions, and the entire wall bows out under the impact. Renaud tosses his cap into the air. "Yeah!" he shouts. "Just a little—just two millimeters apart—and we get the best shoot!" Despite many differences in design and construction, both Wayne's and Renaud's machines have performed with startling precision and predictability.

Medieval historian Michael Prestwich, who witnessed the *NOVA* experiment, was left in no doubt of the trebuchet's impact. "For the first time I had a real sense of how formidable these siege engines could be," he notes. "With a few shots, it's obvious you could do tremendous damage. In the struggle between attackers and defenders that marked every siege, it's very clear to me now that the appearance of a trebuchet on the scene must have shifted the balance radically in favor of attack."

Drying out from our victory beside a log fire, we reflect on lessons no history book could have taught us. Our trebuchets had called for subtle geometry, expert rigging and fastidious timberwork. Centuries before Newton, trebuchet engineers had developed a seat-of-the-pants expertise that involved repeated observation, testing, and a skillful grasp of mechanics. While medieval chroniclers hint at the terrifying impact of machines like the War Wolf, they are mostly silent on the ingenuity invested in their design and construction.

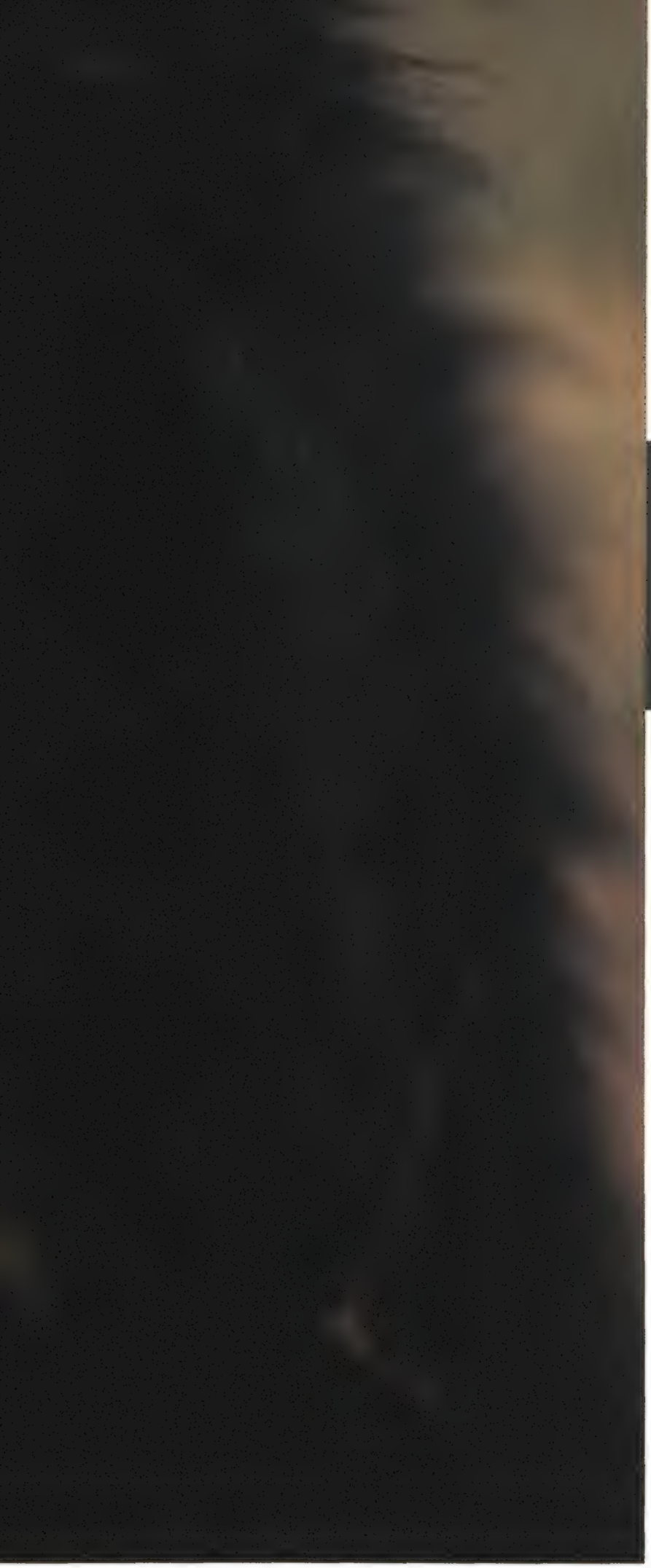
**An impromptu chorus line of timber framers, wearing kilts for luck, celebrates a direct hit.**

Only modern experiment could reveal that these unwieldy contraptions were in practice reliable, high-precision instruments of war, foreshadowing the weapons of far worse conflicts to come.

*Evan Hadingham, Science Editor of* NOVA *on PBS, has written books on prehistory and archaeology. Patrick Ward photographed Letter Boxers for the April 1998* Smithsonian. *He works in the United Kingdom.*

# Sloth Bears

## *They Eat Ants, but Take On Tigers*



Sloth bears have no incisors on their upper jaws, presumably an adaptation for sucking in large quantities of ants and termites. They can still fight with the lower canines, however.

BY ADELE CONOVER

AT FIRST WE SAW ONLY AN ERASER-COLORED NOSE TREMbling in the scraggly vegetation. The male sloth bear, an immense ball of unkempt fur, had caught our scent as it emerged from its den. Huffing and puffing, it charged uphill at us like a runaway train. All I could think of were the pictures I had seen of a villager with a claw-raked face and, even worse, a man without any face at all.

Still used as "dancing bears," they can hold their own with the big cats but not with human expansion

T.R.K. Yoganand and his assistant Mahadev Prasad Yadav jumped up from behind the boulder where we had been watching him. The apparition of two full-grown male humans, bearded and bearlike themselves, yelling and waving their arms, was apparently enough to give the bear pause. It stopped, wheeled about and galloped clumsily off into the forest.

The pictures I had seen were of only 2 of the 80 victims in the past several years who have had the bad luck to run into a sloth bear here in Panna National Park in central India. Now I understood why Yoganand had asked me at the airport, "How fast can you run?"

The urbane and amiable Yoganand, whose friends call him Yoga, has spent four years radio tagging, tracking and studying the sloth bears in India. He has been charged before. But, he admitted, this was a close one. We had been trying hard to "run into" sloth bears, wandering the park in a jeep and on foot, following the *tok-tok-tok* signals of the 12 bears that he has outfitted with radio collars. We had hiked to Yoga's favorite study perch, a series of ledges from which he could peer down a steep escarpment into the Imeliya Valley. In this arena, Yoga said, he had seen mothers and cubs playing, bears fighting and feeding, and bear meeting tiger—and calling it a draw.

The sloth bear is a very aggressive bear, says Smithsonian zoologist John Seidensticker, a veteran of years of fieldwork on the Indian subcontinent and Southeast Asia. "In some areas more people are injured in encounters with sloth bears than tigers." The frowsy ursid is also the original dancing bear, "taught" for centuries to perform by the Qalandars, an itinerant people who roam the country entertaining crowds with performing animals, rope climbing, trapeze walking, puppetry, magic tricks and music. "The bear is smart," says Yoga. "After all, you don't see any tigers riding motorcycles in the circus."

*"One ant alone is a disappointment." A colony, however, can provide quite a satisfying meal.*

The animal made its debut in Western science as the "bear sloth" toward the end of the 18th century. Field notes accompanying the first pelts sent to Europe said they came from animals that had long trunklike snouts and that frequently hung upside down from tree branches in the jungle. George Shaw of the British Museum, influenced by these accounts and noting the animals' three-inch, ivory-colored claws, presumed the former owners to be sloths. In 1810, however, when the first live specimen reached Europe, it was so obviously a bear that its name was simply reversed to "sloth bear."

dining bear's sucking and blowing can be heard 200 yards away, says Nepalese researcher Anup Joshi, who completed the first exhaustive study of sloth bears, in Royal Chitwan National Park, Nepal, in 1994.

In our trek last March through the nearly leafless dry season forest in Panna, Yoga and I often encountered bear sign—archaeological ruins of ant cities, with some holes deep enough for a man to stand in up to his chest. In one dusty red cavern, Yoga picked up a few stunned-looking ants left behind. "Workers," said Yoga of the tiny creatures wobbling between his thumb and forefinger.

Cubs cling to their mother's back for the first nine months of life, even when she is charging a tiger, and will stay with her for up to three years before going out on their own.

Whichever of the Seven Deadly Sins the sloth bear may be guilty of, however, sloth is not among them. With the concentration of a chess master, it spends every waking hour looking for food. Ecologically it is a confirmed omnivore, supping, on rare occasions, on leftover tiger kill. More often it prefers fruits, honey and flowers. But it is specially adapted for sucking up insects. The bear makes quick work of ants, termites and beetle larvae, with its snuffling, vacuumlike feeding apparatus, when it breaks into their galleries. Its long, almost prehensile lips, concave palate and missing front incisors form a perfect Hooverian machine. The bear first blows into the nest, then sucks up the goodies with its nostrils closed to prevent the enraged prey from going down the wrong pipe. The clamor of the

But how can a bear weighing from 150 to 300 and even 400 pounds sustain itself on creatures a zillionth its size? Clearly "one ant alone is a disappointment," as Harvard's Pulitzer Prize-winning scholars E. O. Wilson and Bertold Holldobler wrote in their book *Journey to the Ants*. An ant colony, however, can provide quite a satisfying meal for a sloth bear. Joshi and his colleagues, bear researcher Dave Garshelis, of the Minnesota Department of Natural Resources, and tiger researcher James David Smith, of the Department of Fisheries and Wildlife at the University of Minnesota, speculate that because sloth bears have this special sucking power, they can eat at one time between 4,000 and 10,000 termites, a colony size typical of this area. "That's maybe between a pint and a quart of edible ter-

E. A. KUTTAPAN/BBC NATURAL HISTORY UNIT; PP. 88, 89 AMRIT P. SINGH

*He watched a bear dig small holes, then return later to deepen and enlarge them as it rained.*

mite protein—depending on species and caste," says David Nickle, an expert on termites at the U.S. Department of Agriculture. And that estimate doesn't even take into account the protein-rich larvae or the three- to four-inch-long queens that a bear would be rewarded with, adds Nickle.

"Quite possibly bears have the ability to reason," says the Indian naturalist E.R.C. Davidar. He watched a mother sloth bear and her cub first dig a number of small holes over suspected termite nests and then return later to deepen and enlarge the holes as it rained. "The adult bear was deliberately employing the strategy of making the rain aid its digging efforts, just as a gardener when trying to dig a pit in hard ground would make a small trial pit, pour water to soak the ground; dig a little deeper and pour more water and repeat the process until the desired depth is reached," he wrote.

Sloth bears are consummate botanists. In Panna, they are quick to zero in on the Mohwa trees, whose flowers are also craved by humans. We stop at a Mohwa tree on the edge of the forest, in view of cultivated fields. "Humans use the flowers to produce an alcoholic beverage and also sell them dried in the market as a commodity," says Yoga. The Mohwa flower ferments in 12 hours and "when mellowed with age . . . resembles Irish Whiskey," as one early colonial noted. "The people here think that the bear gets drunk and "dances," I learn, and they say that is the origin of the so-called dancing bear.

Obviously this shared taste for the flower puts sloth bears at odds with humans. In the days of the Raj, an English naturalist noted that the tree belonged to the people during the day and to the bear at night. Now, day is night. "At night the people are out there, too," says Yoga. "You see women and children plucking the blossoms at 3 A.M., sometimes even lopping off an entire branch.

"Panna National Park [210 square miles] may shelter 30 to 40 sloth bears," says Yoga, but it also harbors a considerable number of humans. There are 15 villages inside the park and 50 villages around the park, including one settlement of 300 in the park's center. Panna, says Yoga, is an attractive place for people to live. "There's wood for fuel and places to graze cattle and goats." The government plans to move all the people out of the park, but it has no timetable.

Yoga chose Panna Park as his study site partly because of the human presence. He hired his assistants Mahadev, Jahar Singh Yadav and Utham Singh Yadav from the surrounding villages in the hope that once they better understood the sloth bear, they will act as public relations emissaries for the bears back in their villages. They are

T. R. K. YOGANAND

**A now wide-awake bear charges biologist Yoganand after being caught in a trap, tranquilized and radio collared. It broke off the chase after Yoganand had run about 100 yards.**

In Nepal's Royal Chitwan National Park, a sloth bear rips into a termite mound, oblivious of the humans watching from atop an elephant 50 yards away.

deferential young men who ride off every morning on their motor scooters loaded with radio-tracking gear. They also cook for us.

Humans have shared this turf with sloth bears since time immemorial. According to Wildlife Institute of India (WII) biologist Raghunandan Chundawat, who keeps track of tigers here, Panna Park is pocked with caves whose walls are adorned with prehistoric paintings of wildlife. In one cave, he found paintings of sloth bears. The park, like much of the remaining forest in India, was once a raja's hunting ground and then a British hunting preserve. It is still a wild place. On our way to our near-hammering by the bear that charged us, we spotted leopard scat laced with hair from a sambar (a large Asian deer), a hyena den and porcupine sign, and heard the ever-pervasive rutting call of the axis deer.

Despite the wild ambience, every morning brought a rush hour of humans and their domestic animals past our camp. Sometimes a goatherd with his charges went by. The goats, arrogant as Dobermans, seemed to realize that no one would hinder them from chewing forest vegetation to the nub. Cattle, too, in small groups and alone would head to graze sparse grasses with the pushy resolve of Christmas shoppers. Women in pastel saris, some with pots balanced on their heads, moved through with their children, perhaps to gather firewood. Collectively, they are degrading the bears' habitat.

Although sloth bears do not ordinarily regard humans as prey, they are being pushed into closer and closer contact with people, and bear-human encounters become inevitable. When they do attack, these gap-toothed bears often go for a human's face or head. Although frequently the swipes with its claws do the damage, a sloth bear will also bite and cling "like a bulldog," as a conservator of the Imperial Forest Service put it in 1910. "A mauling from a bear," he said, "is more to be dreaded than death itself," for it leaves "the relics only of what was once a human face."

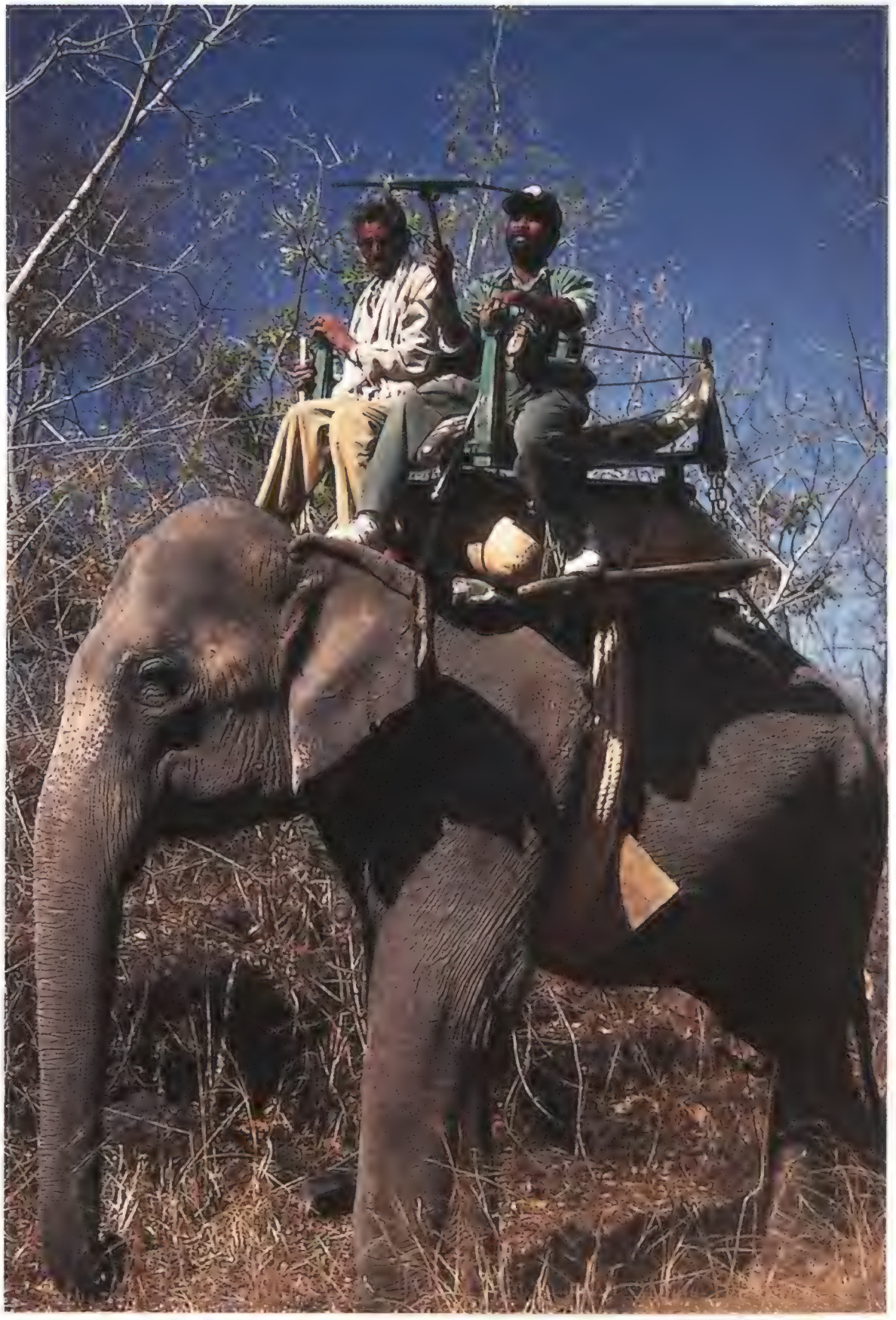
Between 1980 and 1997, bears attacked 80 people in the park. Three people were killed. Almost all attacks followed an abrupt encounter. No wonder the remark by Pravin K. Chowdhry, Panna Park Conservator of Forests, that the "bears do most of the poaching in Panna."

Accompanied by Manu Mathai, a young WII researcher who acted as my translator, I borrowed Yoga's jeep one day to go visit Panna Park residents and talk with them about the park's sloth bears. Everyone I talked to in three villages insisted that contrary to what the authorities said, the number of sloth bears had to be increasing, and it was clear to them that the bears "no longer feared humans." Everyone seemed to know a person who had been

ANUP JOSHI

attacked by a *bhalu*, Hindu for "bear."

Approaching the village of Talgaon over dusty and denuded terrain, we found several weary herders in the shade of an aging temple, their long staffs propped up on the steps, their cattle milling. The settlers make their living by selling or bartering milk and raising subsistence crops such as legumes. Every night in camp as I went to sleep, I could hear the *tap-tap* of a crop guard beating his drum, attempting to keep bears and other marauders out of the fields. The herders, although polite, looked as if they'd been asked too often when I inquired about the sloth bear. One person I spoke to told of a man, out gathering wood in the forest, who had been attacked and killed. The bears, said another man, used to stay at the cliffs a few miles away, but now they "hang around here" for the water at a dam-created lake. At the village, we were met with an offering of water and invited into the courtyard shade of a white adobe dwelling to meet the headman, Girja Prasad, a slender man wearing a gold-colored shirt and white wraparound skirt. The villagers raise a few crops, herd cattle for milk and depend on the forest for their fuel. He assured us that his settlement of 50 households was a protector of the forest, and because of that it had received a letter of commendation from the forest department. Yes, his people were wary of bears. But no one went into the forest alone, he said. "It's OK to run into a tiger or a leopard because they just run away. The bear will attack you."



Yoganand (holding the antenna) and an elephant driver named Khalil follow a radio-collared bear through thick brush in India's Panna National Park.

The headman's elder brother, Heerala, related an incident in which a cranky female and two big cubs attacked a woman, again without provocation. The woman was out grazing her cattle when the bears struck from behind and knocked her down. Every time the woman tried to rise, the bears mauled her. Finally she decided to play dead. The bears, Heerala insisted, returned three times to see if she had moved. She survived.

Sloth bears are born hairless and helpless. The mother remains in a cave with her young for up to 35 days after giving birth, rarely venturing out to eat. When she does bring the cubs out into the world, they travel on her back, clinging to her long hair. They stay attached whether she's digging for ants or charging a tiger. At about three months the cubs start to briefly abandon Mom's back to play and sniff at whatever she digs up. When scared they retreat to Mom again. Anup Joshi says he once saw two cubs practicing climbing trees and looking for beehives. When one got stuck, the mother bear came to its rescue. Like primates and elephants, they have an extended childhood to learn all they must know. Joshi's work verified that sloth bear cubs stay with their mother for up to three years, at least a year longer than any other bear species.

An orphan cub found in Chitwan National Park con-

ADELE CONOVER

In Rajasthan, India, a man displays his captive bear. (Note the rope through its nose.) He makes money by allowing tourists to take pictures of the bear or of themselves with the bear.

firmed for Joshi that the mother bear's tutelage is essential. Early in the study, park wardens found the motherless cub wandering about, and took it to Joshi's camp. "I felt sorry for it and thought I could use it for a research bear. The original plan was to raise her—we named her Kali—as wild as possible and reintroduce her into Chitwan when she grew up."

But, says Joshi, "Kali was a disaster." The cub went from a cute 5½ pounds to a chubby 140 pounds (an average weight for an adult female) by the time she was 18 months. "She became the pet of the camp." Although Kali figured out on her own how to dig, presumably for ants or termites, she failed the ultimate test. When presented with a termite nest (above ground), says Joshi, she would go for the wrong part. And when she climbed 80 feet up in a tree, she couldn't get down until somebody coaxed her. Frequently, after a furlough in the forest, she ran back to camp and hid. Once she was badly wounded from some altercation with another animal. "Clearly she had a lot to learn, and since we weren't sloth bears, we couldn't teach her," Joshi added. Kali ended up in the zoo in Kathmandu where her former "family" visits her frequently.

Joshi and his colleagues, Garshelis and Smith, discovered that when the young leave the home front, siblings often pair up. Their world is dangerous, says Smith; they are surrounded by tigers and leopards. During his tenure in Panna, Yoga says, tigers have killed four sloth bears.

But sloth bears will stand and deliver when faced with a large carnivore. In Chitwan, Joshi saw a male haul off and slap a large tiger in the face and then push the big cat away. The tiger took off. Smith once watched a sloth bear rout three tigers as a fox might scatter a flock of chickens; the tigers dashed away from the bear in different directions. "They were large tigers and could've killed her with no problem but likely realized they'd get hurt in the process," Smith said.

Unlike female tigers, female sloth bears don't defend territories. Although generally testy and solitary, and clearly

KEVIN SCHAFER/PETER ARNOLD

not fond of tigers, most female sloth bears are remarkably abiding in their relations with their sister sloth bears. They don't fight over territory, like our North American black bear females. And although Joshi says that females trucking cubs around seem to avoid males, Smith points out that "we did not see any cub killing by males."

Sloth bears need as big a gene pool as they can manage. The fragmentation of their habitat has created isolated populations with gene pools too small for optimal reproduction. Like big carnivores everywhere, they are disappearing. An estimated 7,000 to 10,000 sloth bears survive on the Indian subcontinent today, a fraction of their former numbers. Sloth bears once ranged throughout Bangladesh, Bhutan and Sri Lanka as well as India and Nepal.

The decline of the species was accelerated with the assault of the British on the wildlife and forests of India. Evolution had stamped an unfortunate white V on the bear's chest, which British hunters regarded as a convenient target. The colonials considered the bear both crop-raiding vermin and quarry, a bit of fun. By the middle of the 19th century the bear was already gone from the Deccan Traps and Bengal, where it had been common 30 to 40 years earlier. The number of wild bears was rapidly decreasing by 1968, when one forest warden wrote, "Collateral evidence of this decline is provided by the fact that in South India, the itinerant man-with-the-performing-bear, once so common, is almost as rare as the bear itself. . . . " Now, although it is no longer hunted for sport, it is poached for its gallbladder, as are most bear species around the world. The gallbladder is highly prized in Asia for its supposed medicinal powers.

**A zoo animal displays the white V that colonial hunters found such a convenient target.**

Some blame the animal's current state on the Qalandars' continued use of the bears for entertainment. Capturing and trading in bears in India was made illegal in 1972, but until recently the law was rarely enforced. The 1,200 or so performing bears are mainly seen along the roads from Delhi to Jaipur and Agra, standing on their hind legs, lifting their paws and shaking their hips. Researchers Geeta Seshamani and Kartick Satyanarayan of the World Society for the Protection of Animals, reporting in 1997 on their 18-month study of the Qalandars and the dancing bears, found that it is urban and tourist audiences that want to see the bear dance. Rural villagers, irrespective of caste and religion, only want to see the bear, by tradition the protector of little children and a defender against spirits.

According to Seshamani and Satyanarayan, the cubs are abducted from their dens when they are about 3 to 5 weeks old. The Qalandars camp near the forest edges of Orissa, Madhya Pradesh, Uttar Pradesh and Karnataka, where cub markets appear from November to mid-March. The cubs, age 3 months or younger, bring $70-$115. When a cub reaches the Qalandars' main village, it spends a couple of weeks with its new owner. If it is resold, it brings up to $185. A trained adult sells for up to $575.

The bears are fed a mush of porridge until they reach 6 months of age, after which they dine on bread mixed with milk. The Qalandars believe such gruel does not "excite" the animals. Ropes laced through pierced cheeks and noses keep the animals under control.

For the wild sloth bears still hanging on in India, life is considerably better, of course, and it may be even better than we know. Yoga has written that he wonders if the bears enjoy panoramic views of the park; he has found their sign along a cliff and the jutting ledges below, places that look down on the forest.

He maintains that they are shy creatures that time and again have run away after a bluff charge at him. "Do they think I'm another bear . . . or do they wonder, now what is that fellow up to?" In the end it may not matter what these creatures "think," as their future is inextricably linked with humans who, for the most part, view bears as competitors, threats, or opportunities to make money.

In India, it is considered unmannerly to call someone by his or her first name. People are referred to by their surnames. Yoga's staff, and others who have worked with him and the sloth bears in the park for four years, express not only their respect for the young researcher but perhaps also a new attitude toward the beleaguered animal by referring to both as *Bhalu sahib*, "Bear sir."

*Adele Conover wrote about saker falcons in Mongolia in the February 1999 issue and about black bears in Minnesota in April 1983.*

BARBARA VON HOFFMAN/ANIMALS ANIMALS

# BRECK girls

BY MIMI MINNICK

TWO YEARS AGO, I MET THE WOMAN OF EVERYONE'S DREAMS. HER NAME was Roma Whitney, and she became one of the original Breck Girls in 1937, when she was 17. Hers was the face that launched the Breck Company's first national advertising campaign in 1946, and her image was registered as the company's trademark in 1951. Her haloed blonde profile, the dynamic tension between her defiantly uplifted chin and her downcast eyes, spoke to me across a gulf of more than 50 years, and I couldn't help but wonder what message her image had carried to the women of her day.

As one of a team of archivists responsible for acquiring 20th-century advertising history records for the Archives Center of the Smithsonian's National Museum of American History, I am accustomed to having my head turned by some of the millions of pieces preserved in the museum's collections. The Breck Girls collection was one I simply couldn't resist.

I first saw their pastel portraits when, in 1998, following initial contacts by Nance Briscoe, a colleague whose mother was a Breck Girl, I acquired original Breck advertising art and print advertising from Dial Corporation, owner of the brand since 1990.

The Breck Girls portraits were born during the Depression and came of age in the 1940s and '50s, times that shook cherished values, including long-held beliefs about the roles of men and women. Advertising executives responded by crafting and presenting idealized images of an American woman they thought everyone could love, a woman both desirable and chaste. These images from our Breck Girls collection testify to the tenacity of that ideal.

I also discovered that Breck Girls were and are real women. I've heard from about a dozen who admit they still sometimes think of themselves as Breck Girls, and it's that connection between the real and the ideal that intrigues me most.

In 1936, Edward Breck, son of the founder of the Springfield, Massachusetts, shampoo company, engaged the services of Charles Sheldon, a commercial artist living in the area. Sheldon's early portraits for Breck depicted provocative, even sensual, female poses executed in pastels, with soft focus and haloes of light and color to create highly romantic images of feminine beauty and purity. Sheldon and his successor, Ralph William Williams, perfected a vision of American womanhood that resonated powerfully for more than 50 years. Today the shampoo is still around—but the Breck girls are a part of history.

Charles Sheldon (opposite, top) drew scores of portraits for Breck ads from 1936 to about 1959. His models included friends, employees of his advertising agency and others he found around his hometown of Springfield, Massachusetts, such as the women on these two pages (clockwise, from lower left): Marilyn Skelton, Roma Whitney, Peggy Cullen, Jean Ivory, and Britta Reed. Marilyn Skelton appeared in portraits at least ten times, Jean Ivory eight times and Peggy Cullen three times.

According to Breck Company lore, Charles Sheldon had studied in Paris under the renowned Art Nouveau illustrator Alphonse Mucha. Despite his style's sophisticated, Continental origins, Sheldon preferred to draw "real" women as opposed to professional models. Breck family members provided many of his early subjects, including Elizabeth Pratt Breck (below), mother of Edward Breck. Ralph William Williams succeeded Sheldon as artist in the late 1950s. Brighter colors and a heightened sense of movement and individuality distinguished his work. Williams, unlike Sheldon, added his signature to the Breck Girl portraits he painted. Breck cosponsored the America's Junior Miss pageant to boost brand identification and locate promising young models. Subjects included Karen Stenwall (top left), Judy Neumann (top right) and Donna Alexander (right), one of the few African-American models.

BRECK
GIRL
DONNA ALEXANDER...
of East Orange, New Jersey.
As New Jersey's Junior Miss for 1974, Donna represented her state in the national competition and was awarded the scholarship for Academic Achievement..
Donna is now studying veterinary science at the University of Pennsylvania.
the only leading shampoo that isn't mostly detergent...GOLD FORMULA BRECK

ALL: BRECK GIRLS COLLECTION, ARCHIVE CENTER, NATIONAL MUSEUM OF AMERICAN HISTORY; P.99 PHOTO: COLLECTION OF CAROL TOBY CHEEK

BRECK
GIRLS
Ann Basinger and her daughter, Kim, of Athens, Georgia.
Ann and Kim share many interests. Dress designing, cooking, modeling in local stores, long walks on the beach, a love for all animals.
They use special care to keep that "beautiful hair" look.
They've both always been Breck Girls.
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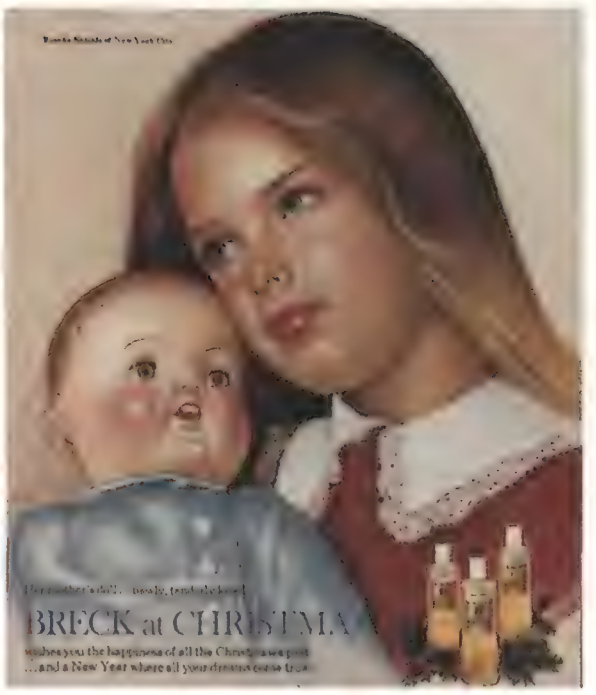

Said a Breck Company executive of Ralph William Williams: ". . . in later years, as women became more independent, he would take care to integrate each girl's particular personality; he studied each girl and learned her special qualities." Breck ads ran regularly in such major monthly magazines as *Ladies Home Journal*, *Woman's Home Companion*, *Seventeen*, *Vogue*, *Glamour* and *Harpers Bazaar*. Eventually, Breck began to employ professional models such as Carol Toby Cheek (bottom left, in 1955 and at the Breck Girls Hall of Fame reunion in 1992). Actresses and supermodels like Kim Basinger (top left, with her mother, Ann Basinger), Brooke Shields (above, featured in a Christmastime ad at age 9), Erin Gray, Cheryl Tiegs, Jaclyn Smith and Cybill Sheperd were Breck Girls early in their careers. After Williams' death in 1976, the campaign trailed off and ended in 1978, although it was briefly revived in 1995.

# YALTA: *Witness to History*

BY ROBERT WERNICK

WHEN THE BIG THREE—CHURCHILL, ROOSEVELT AND STALIN—CONVENED AT THIS FABLED CRIMEAN SEASIDE RESORT IN 1945, THE WHOLE WORLD WAS WATCHING

**With the Black Sea and Crimean Mountains as a backdrop, picturesque Yalta was one place in Russia warm enough to hold a summit in February.**

IT WAS THE DREAMHOUSE OF A MAN WHO HAD POWER and money enough to make dreams come true. Livadia Palace stands today almost exactly as he ordered it, with all its modern conveniences of elevators and hot and cold running water, built of white limestone in the fashionable Italian Renaissance style of its day. It was all put up in less than 18 months, with every one of its 116 rooms offering superb views of garden or forest, half-mile-high cliffs of the Crimean Mountains just to the north, or the endless blue of the Black Sea just to the south. A couple of miles to the east were the leafy streets and elegant villas of the seaside resort of Yalta, where the rich and wellborn of Russia had been coming for a century to bathe and show off their elegance, and forget the Russian winter. "We don't find words to express our joy and pleasure at having such a house," he wrote to his mother, "built exactly as we wished."

He was Nicholas II, czar of all the Russias, a kindly, uninteresting man, passionately devoted to his wife and his five lovely children, and this was a place of sun and tranquillity, protected by a majestic mountain range from the arctic winds that roamed the rest of Russia at will. It was a place where he could listen to the fountains plashing among the exotic plants in his immense gardens, walk in the woods with his family, climb mountains, enjoy tennis, read Sir Walter Scott at night, play billiards, hold lavish dinners, worship in his garishly ornate chapel, take photographs of his family at play (with one of the first Kodaks put on the market) and forget all the tiresome responsibilities of ruling the second-largest empire in the world.

It was all made ready for him in the happy year of 1911, just three years before he was to lead his unready nation into the disastrous folly of World War I. It was seven years before he and his wife and all five children were to be murdered by soldiers of the Russian Revolution, in the cellar of a house a thousand dreary miles away from his palace of Livadia.

Livadia and its grounds have been studiously and handsomely restored. Hundreds of people come daily to look at the family photographs on the walls and the charming watercolors of the garden, painted by the princesses Olga and Tatiana, and the czar's library and his billiard table. Many of them pray in his chapel, for the Russian Orthodox Church may soon begin the process of declaring Nicholas a saint.

But, of course, for most of the visitors, Nicholas II and his family form only a tangential object of curiosity. The crowds come to Livadia because they remember that it was for eight days, in February 1945, the meeting place of three men on whom all the hopes of humanity were centered. Yalta was a spot of sunlight shining through the black war clouds that had smothered the earth for five and a half unrelenting years.

They were the Big Three; their pictures appeared in every newspaper and newsreel in the world, and later in all the history books—bulldog

Gathered with their tutor on the terrace of Livadia Palace, the princesses Olga and Tatiana, daughters of Czar Nicholas II, take their lessons in the open air, c. 1914.

CORBIS/AUSTRIAN ARCHIVES; PP. 100, 101 ROBERT HAIDINGER/AGENTUR ANZERBERGER; P. 101 HULTON GETTY PICTURE COLLECTION

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Winston Churchill with his cigar, wan and dying Franklin Roosevelt making heroic efforts to flash his great glad-hand smile, Joseph Vissarionovich Stalin with his sly Caucasian-bandit grin—all beaming with friendship and contentment as they studied the map of the world in the dining room, or relaxed outside under the Crimean sun in the Italian courtyard.

The Italianate splendor of Livadia Palace, formerly the czar's 116-room dreamhouse, was the setting for all the meetings among the three leaders.

Attending the Crimean Conference—which the world inaccurately but incorrigibly insists on calling the Yalta Conference—required a long and potentially hazardous journey for the two leaders of the democratic world. Roosevelt first had to take a 6,000-mile voyage by Navy cruiser to Malta in the middle of the Mediterranean for a meeting with Churchill, who had flown down from London. (One of the British planes that carried Churchill's staff crashed on the way, killing most of the people on board.) After briefly reviewing the world's military and diplomatic state, the two leaders flew off with some 700 attendants—diplomats, military staff, technicians, typists, doctors, as well as a sightseer or two, like Churchill's daughter—in 25 four-engined planes on a 1,400-mile course that swerved well out of the way of interference by enemy planes, over the eastern Mediterranean, Turkey and the Black Sea to land at Saki airfield in the Crimea. The entourage then took an eight-hour automobile ride, with concerts by military bands and picnics of champagne, vodka, caviar and sturgeon along the way, over winding mountain roads to the palaces that had been prepared for them.

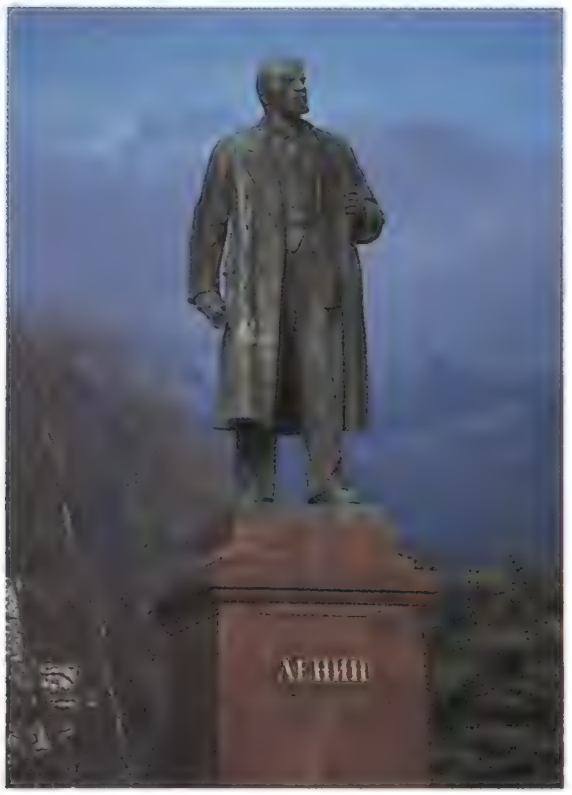
Roosevelt was lodged in the Livadia Palace which, as a gesture to his infirmity, was also the site of all the meetings among the three leaders. Churchill was put up ten miles away at the Vorontzov Palace, an extravagant 1830s manse, in Alupka.

Everything had been brought down 800 miles from the most fashionable hotels in Moscow to make a suitably luxurious setting for this summit of all summit conferences—the servants, the silver, the glassware, the vodka, the carpets and hangings. There was, as Churchill's physician Lord Moran put it, "nothing left out but cleanliness." (American DDT took care of

DAVE G. HOUSER

the bedbugs that gnawed at the Prime Minister's feet on the first night.)

Churchill once said, "We could not have found a worse place for a meeting if we had spent ten years on research." But he had to make the best of it. It was the only place in Russia both warm enough in February, and undamaged enough by the war, to be suitable. And the conference had to be in Russia, partly because Stalin's doctors warned him against long journeys (he was said to have had a heart attack on the way back from the previous Big Three meeting in Tehran, 15 months earlier), but mostly because Russia was where the action was. Stalin was personally directing the great Russian offensive, which had driven to within 50 miles of Berlin. And the Russian front remained, as it had been for three and half years, what the Western Front in France had been in the last world war: the decisive battleground. In the years 1941-1943, beginning with Hitler's invasion of Russia, 94 percent of German Army casualties were in Russia, 6 percent in what the U.S. Secretary of War called "pinpricks" delivered



No one has bothered to topple Lenin's statue, still looming large in Yalta.

ROBERT HAIDINGER/AGENTUR ANZENBERGER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by the British and Americans in North Africa, the Balkans, Italy and the skies over Europe. Even when U.S. and British troops invaded Europe in force in 1944, they were playing second fiddle: in the two months in which they won their greatest victory, the Battle of Normandy, when they could count 530,000 German casualties, the Russians on their front could count 700,000.

As the three leaders sat down for their first joint session in the dining room of the Livadia Palace at 5 P.M. on Sunday, February 4, they were at the zenith of their power. The Big Three were old men (they were all over 60!) who had spent their lives clambering up what Disraeli called the "greasy pole" of politics (in Stalin's case there was much blood mixed with the grease). Each of them had seen their war begin with sudden, catastrophic defeats for their countries and their closest allies—the wiping out of the French Army in the spring of 1940, the wiping out of half the Russian Army in the summer and fall of 1941, the attacks on Pearl Harbor and Manila in December 1941—but all had rallied their nations, fought back and, at least in Europe, turned the tide.

They had managed to hold together what Churchill called a Grand Alliance of dissimilar and, in some cases, fundamentally hostile partners. They had moved millions of men, thousands of ships, tens of thousands of airplanes, over more immense distances than any previous war had known. They had all made mistakes, sometimes disastrous mistakes—the casualties resulting from Stalin's panicky order not to retreat an inch when the Germans attacked in the summer of 1941 numbered in the millions. But unlike Hitler, who lost his head when he began losing battles, they had learned from their mistakes.

People who insist that no single individual can influence the course of history should consider what things would be like today if the Big Three


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had all been killed by a bomb or an assassin's bullet in 1941, and the Allies had been led through World War II by Henry A. Wallace (FDR's vice president), Clement Attlee (next in Britain's wartime chain of command), and whomever the Politburo might have picked to succeed Stalin.

Now that the war the Big Three had waged so doggedly was thundering toward its conclusion, the world was waiting for them to find the formulas for a new and lasting peace.

At Livadia, the cavernous expanse of Nicholas II's former billiard parlor became the room where, on February 11, 1945, the declarations were signed.

And they gave the world what it wanted. After eight days of talks, they put their signatures to documents promising that they would help the liberated peoples in "the earliest possible establishment through free elections of Governments responsive to the will of the people," and would go on "to build in cooperation with other peace-loving nations a world order, under law, dedicated to peace, security, freedom and general well-being of all mankind."

It was, however, the last hurrah of the Big Three, for the "settled peace" they had foretold soon dissolved into the less pleasing prospects of the Cold War. An increasingly bitter disillusionment set in, as the fine words of the declarations were translated into deeds on the ground. Soon the very word "Yalta" became a term of abuse. It was held to be responsible for almost everything that was to go wrong in the next half-century. Roosevelt was accused of having betrayed freedom and given Eastern Europe away to the Communists. In Russia, after Stalin was safely dead, Russian generals wrote books suggesting that Stalin had betrayed his people at Yalta by calling off an offensive headed for Berlin. That push might have scooped up all of Germany along with its industrial might while the Western Allies were still bogged down in the snowdrifts of Belgium.

In the blinding clarity of hindsight, 55 years later, both the early enthusiasm and later revulsion seem like emotional explosions with little or no connection either to what the Big Three did at Yalta or to what the state of the world was in February 1945.

One overwhelming ingredient of that state was that there was a war on. Germany was on the verge of total defeat, but it was not yet defeated. Only six weeks before the conference opened, the supposedly shattered German Army had stunned the

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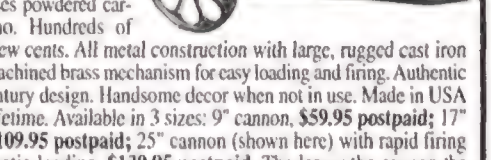

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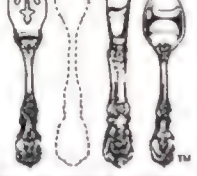

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Western Allies with a powerful offensive in the Ardennes—the Battle of the Bulge. Until that incursion began to peter out after two or three weeks, it caused panic at headquarters and loud appeals for a Russian offensive in the East to take off the pressure. A few weeks after the conference, Hitler deployed his forces to Hungary, where they held up a Russian advance for almost three weeks. Day-and-night bombing had not yet wiped out the German war industry. And Germany appeared to have an ominous technical lead over the Allies of several months—which in a total war could be equivalent to light-years—in weapons of the future like jet aircraft, rockets and silent submarines.

The military staffs at the conference estimated that it would take at least five more months of fighting to stamp out the last Nazi resistance, and another year or more to conquer Japan. As it turned out, it took only three months to take care of Germany—three months in which American Lend-Lease contributed millions of dollars' worth of tanks, trucks, fuel and food, because without them the Red Army could advance only at the pace of a foot soldier, and a million German soldiers might be freed to face the Americans on the Rhine. And the Red Army kept swelling the rivers of blood it had been shedding since June 22, 1941—some 11 million dead, more than half the American and British armed forces combined.

Until the last shot was fired, the Big Three were very much in the position of the members of the Continental Congress to whom Benjamin Franklin said, in 1776, that they had to hang together or hang separately. It was not a moment to fight among themselves about the division of the spoils of war.

Despite all the smiles and the backslapping around the czar's dinner table, Churchill, Roosevelt and Stalin were operating in an arena of distrust. Different interests and different values

lay at stake; language barriers were formidable. The Western powers could not forget that Stalin had colluded with Hitler and sat out the war for two years, from 1939 to 1941, while Germany was devouring half of Europe. The Soviets could not forget the three years from 1941 to 1944, when America and Britain marshaled and trained their invasion armies in comparative comfort in England while millions of Russians did the fighting and dying.

But they had to hang together. As long as guns were being fired, they had to present a united front. So, at Yalta, they talked and talked, they haggled over details, they flattered each other, they toasted each other. They made a few minor concessions. Though they might make barbed references to past grievances and betrayals, they rarely raised their voices, as was to occur dramatically, later that year, at the Potsdam Conference. (President Truman made a proposal for international supervision of the Danube River, which was almost entirely under Russian control. Stalin, breaking into the English language for the only time during the meeting, said very firmly, "No! I Say No!")

They loudly proclaimed their own frankness and sincerity. "I, as a naive man," said Stalin piously, "think it best not to deceive my ally even if he is a fool." At one point, Roosevelt asked if some members of the puppet Polish government, which Stalin had set up in Lublin, could not be invited to put in an appearance at the conference. Stalin—who loved to do things like call factory managers at 3 in the morning to find out if they were doing their jobs—said it was a very good idea. Unfortunately, Stalin added, the Polish leaders had left Lublin for other cities and he didn't have their phone numbers.

Sometimes the Big Three found that they could work out a compromise on some secondary point. But when it came to the vital questions—the shape of the future Europe, the kinds of governments that would take over the newly liberated peoples, what would be done with conquered Germany, what kind of reparations Germany would have to pay for the

At the famous round table where negotiations took place, FDR and Churchill confer with the President's press secretary, Stephen Early, center.

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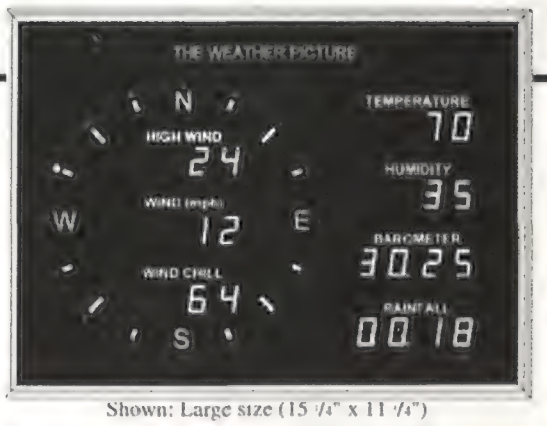


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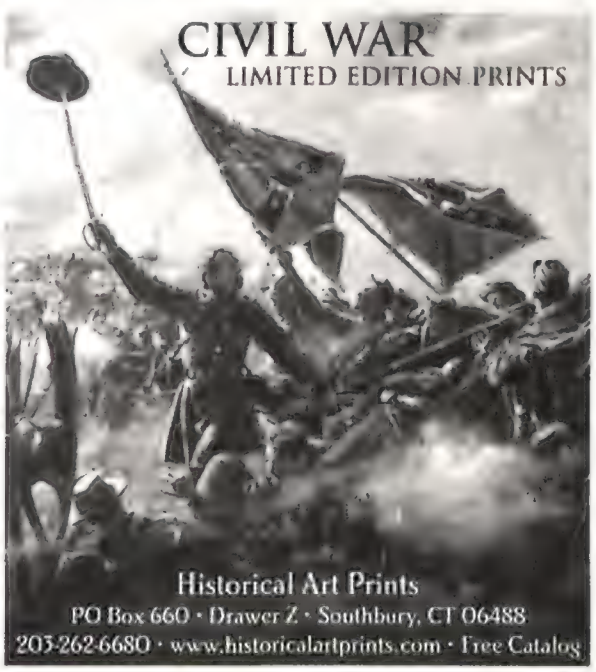
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misery and destruction that it had caused—the differences were too profound. They only could be postponed for future consideration or papered over with general statements.

Stalin had his own word for this kind of paperwork, as he had once explained to British foreign secretary Anthony Eden. It was "algebra." Algebra is full of *x*'s and *y*'s, which can stand for anything you want. Stalin much preferred arithmetic, he said, full of hard, definite figures.

The documents signed at Yalta were a triumph of algebra, full of *x* and *y* words like "democratic institutions" and "free and unfettered elections" that meant very different things in Moscow than they did in London and Washington.

It is easier to list the things that the Big Three did not do than the things they did. Despite the persistent legends that have grown up over the years, the Big Three of Yalta did not divide Europe into East and West; it was clearly going to be divided, in some way, based on the regions that the Russian and Anglo-American armies had occupied. They did not divide Germany into zones of occupation; that had been decided upon in October of 1944. They did not invent the notion of veto power in the Security Council of the United Nations; that had been tacitly agreed upon already. Instead, limitations on that power were negotiated at Yalta.

What they did do was to make promises of future cooperation and eternal amity. At a farewell banquet in the Vorontzov Palace, Churchill declared grandly in his toast to Stalin that "the fire of war had burnt up the misunderstandings of the past."

The next day they all went home and recommenced their misunderstandings in line with their separate national interests. Stalin would show how he interpreted the algebraic words "free and unfettered elections." Within two weeks, he sent one of his hatchetmen, Andrei Vyshinsky, to Bucharest to present King Michael

The specter of war hung over deliberations in Yalta: in the previous six weeks, Allied troops (above) had been fighting off a German offensive at the Battle of the Bulge.

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with a list of the good Communists with whom he was to constitute the democratic government of liberated Romania, or else. The Allies, having failed to come to the slightest agreement on German reparations, simply took what each was in a position to get. The Russians carted off 450 complete factories. The Americans, with their keener sense of profit, made off with the team of German rocket scientists who would help give them an insurmountable lead in the race into the technological future.

Then, on August 8, 1945, Stalin declared war on Japan—three months after the surrender of Germany—just as he had promised in a secret agreement at Yalta. Perhaps it was a coincidence that he did it less than 48 hours after the first atomic bomb was dropped on Hiroshima. But, as Stalin likely understood, that event had changed the power structure of the world forever and relegated any agreements that might have been made at Yalta to, as a French journalist put it, prehistory.

Yalta itself, like the rest of Europe, could now go back to digging itself out of the rubble of war. The buildings that had been blown up or vandalized by the retreating Germans were rebuilt. New Soviet-style housing projects, referred to by one observer as "chicken-coops," were put up. The lavishly upscale homes of the new "czars," from Stalin to Gorbachev, and their ranking underlings, dotted the surrounding hillsides. Those privileged few could come here to live in princely style in the sun and momentarily forget the burdens of running the second greatest power in the world. Nikita Khrushchev was vacationing in one of those homes when he learned he had been booted into the ashcan of history by his friends in the Politburo in Moscow in 1964. Mikhail Gorbachev was here, ensconced in an even more elegant home, when he was arrested by agents of the hard-line Stalinists who

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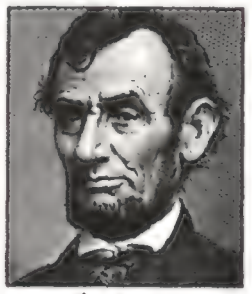

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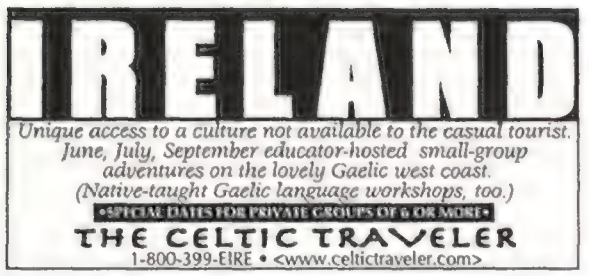
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seized power for a few hours in 1991.

"I was 10 years old," recalls a witness of Stalinist-era Yalta, "going to a girl's school which was near the Livadia Palace where Stalin was staying. One day we saw him going up the road in his big car. He was a funny-looking little man with red hair and freckles. Of course we all adored him, he was the savior of our country. When his car was out of sight, along came a bunch of sinister men in black running as hard as they could. We all naturally assumed they were some of the imperialist spies who were always plotting against the Fatherland, and we began pelting them with stones. It turned out that they were KGB men, Stalin's bodyguards. Things might have gone very badly if my father, who was director of the school, hadn't been related by marriage to a former boss of the KGB. So all that happened was that they moved the school a few miles away."

Not everyone had such fortunate connections. As Nikita Khrushchev would make clear—first to Communist Party leaders in his "secret speech" in 1956, and then to the world, when that speech became public—"Uncle Joe" was hardly a gentle man. In his speech, Khrushchev mentions many ethnic groups that Stalin had deported, joking, "The Ukranians avoided meeting this fate only because there were too many of them." He did not bother to mention the Crimean Tatars, descendants of the warriors who came from Central Asia with Genghis Khan. They had formed about a quarter of the Crimean population before the war. On the pretense that the Tatars had shown insufficient enthusiasm for the Soviet cause in the Great Patriotic War, in May of 1944 Stalin had ordered them to be rounded up and flogged into cattle cars, which took them—or the half who survived—to a bitter exile in Central Asia.

Apart from Khrushchev's landmark speech, there were few dramatic events marking the long, quiet years of a slowly deteriorating postwar economy. One notable exception occurred in 1954, during the 300th anniversary of the cession of Ukraine to the czar in Moscow. Whether because Khruschev wanted to simplify administrative problems or because (in the version favored by Yalta's citizenry) he was dead drunk, he signed a fateful decree. That dictum handed over the Crimea, part of Russia for nearly 200 years, to the Ukrainian Soviet Socialist Republic. Nobody paid any attention; all orders about every aspect of life came from Moscow anyway.

*Then, in August 1991, Ukraine suddenly and unexpectedly became an independent republic. All sorts of problems arose.*

Then, in August 1991, Ukraine suddenly and unexpectedly became an independent republic. All sorts of problems arose, notably including the 300 warships of the Soviets' Black Sea Fleet, which was based at the Crimean port of Sevastopol, around which the Crimean War had taken place nearly a century and a half earlier. (One of the few pleasures Winston Churchill got out of the Yalta Conference was the opportunity to visit the site of the "Charge of the Light Brigade.") After much controversy, the fleet still sits in the harbor, costing the Russian and Ukrainian treasuries vast sums of money to keep it from rusting away.

There were problems for the people of the Crimea, too, because bare-

ly 10 percent of the population can speak the Ukrainian language. There are few if any Ukrainian newspapers in the Yalta newsstands, where the most prominently displayed items are Russian translations of Stephen King and the Russian editions of *Playboy* and *Cosmopolitan* magazines.

Nobody in the throngs of bronzed and healthy-looking people who swarm up and down the promenade along the pebbled beach at Yalta finds anything unusual about this situation. There is, after all, a long tradition in this part of the world of living under the control of foreign despots—Viking pirates or Tatar khans or Muscovite czars or Bolshevik commissars.

Not long ago, there was another international conference held near Yalta, this time a conference of mathematical physicists. As they got up to present their latest equations, they discovered that the blackboards, which had been provided by one government agency, and the chalk, which had been provided by another, were not compatible. The scientists had to develop a kind of sign language to communicate the latest secrets of the subatomic universe.

When I reported this episode to a teacher in Yalta, she showed neither surprise nor interest. It happens in our school all the time, she said.

Like the learned mathematicians, the teacher and her fellow citizens have learned to make do. They barter, they make black-market deals, they take illegal and unreported jobs, they scrounge. They manage to feed and clothe themselves and keep up their rickety old cars and spend vacations promenading on the waterfront of Yalta through deafening blasts of rock 'n' roll music, frugally dispensing small pieces of cash for balloons and hot dogs. But they avoid the tony restaurants, where the staff stands around in listless silence, waiting for vacationers who can afford to order a meal that, with a bottle of fine Alushta wine, may cost $20, or more than half the average monthly wage.

In the meanwhile, they have the standard resource of disadvantaged peoples, which is to tell funny stories about their rulers. Did you know that the most prosperous group of workers are the traffic cops? You can often see them along the boulevards of Kiev and other cities, holding animated discussions with stopped drivers over how much cash they must produce

FRANK S. BALTHIS

Even on a chilly day, crowds enjoy strolling Yalta's boardwalk. Foreign tourists, however, remain a rarity at the Crimean seaside retreat.


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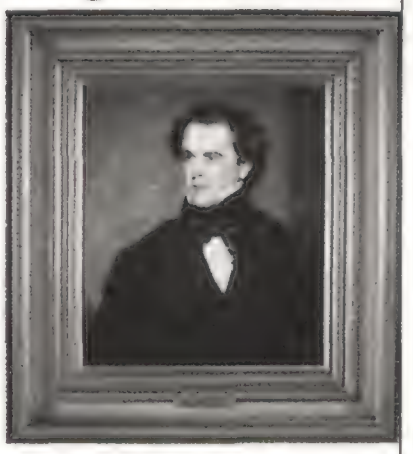

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to keep from getting a ticket. At the curb, meanwhile, the gleaming Mercedes of the former Soviet functionaries who run the government and the profitable parts of the private business sector, stand in silent pride alongside the No Parking signs in front of the public buildings.

A member of this governing elite, the speaker of the Parliament, was interviewed recently by the press. He was asked what had become of the $70 million loan he had gotten from an American bank for importing agricultural equipment, a loan that was paid off in full, plus interest, by the Ukrainian government. He replied: "Show me the dollar I touched. You know it was a credit in commodities. I could misappropriate a combine, a truck, or herbicides. But how could I steal the money if the Americans did not give even a cent in cash? Really, it is funny."

With such leaders, it is hardly surprising that both the population and the Gross National Product of Ukraine have plummeted in recent years. Yet Ukraine, with its immense mineral, agricultural and scenic resources, is potentially one of the richest countries on earth.

The Crimea, especially, is a tourist paradise waiting to be born. It has everything that the Italian and French rivieras have in the way of soft blue sky and gentle climate, beaches, mountains and deep blue sea, ancient ruins and romantic chasms—everything but the overcrowding and the pollution. And it has a friendly, well-educated population, picturesque Tatar peasant villages (for the exiles have been permitted to dribble back in the past few years) and the Livadia Palace besides. But practically no foreign tourists come here, except for a couple of weekly planeloads of Germans and some Moscow mafiosi.

The problem, says one former Peace Corps volunteer in Yalta, is that the area is surrounded by unattractive, often unfinished, concrete buildings. Rusted cranes stand as if their operators left for lunch years ago and never returned. There is running water only 6 to 12 hours a day in the summer, and most services—from elevators to public transportation—are slow and unpredictable.

The United Nations sent a mission here to teach the local people something about the business of luring tourists and keeping them satisfied. But at least one foreigner living here told me he considers the task hopeless. Ukraine is run by people, in his opinion, who were brought up in a system where private tourists were regarded much as were private businessmen, germs capable of spreading dreadful infections in the body politic. You cannot change such mentalities overnight, he said; we will have to wait decades to give a chance to the young people who are aching to make something of their lives.

His scenario may err on the pessimistic side. Sometimes things can happen fast in this part of the world. They are generally calamities, it is true, like Stalin's collectivization of agriculture in the 1930s that killed millions, or the murderous invasions of Genghis Khan and Hitler.

But less unpleasant things can happen quickly, too. It was less than 20 years ago that a Ukrainian nationalist, carrying his message to Washington, was told by a U.S. official that the very idea of an independent Ukraine was as phony as a three-dollar bill. And anyone then would have been considered a hopeless dreamer if he had predicted that Poland, not to speak of Romania and Bulgaria and Azerbaijan, would have, before the end of the millennium, an independent government chosen in a free election. This is exactly what the Big Three promised at Yalta in 1945, though they would have been as surprised as the rest of us to see it happen.

*Robert Wernick, who writes frequently for* SMITHSONIAN, *also reported for the magazine on the history of summit meetings.*

**A Mediterranean Feast**

Clifford A. Wright

William Morrow, $35

*In southern Europe, people ate cabbage. They ate olives and cheese, ham and salted fish.*

MEDITERRANEAN CUISINES are more than olive oil, pasta and rough red wine. They combine foods that have been grown, gathered, hunted or herded since the dawn of civilization, with ingredients and techniques imported from around the globe during more than two millennia of exploration, trade and conquest. Mediterranean dishes can be as simple as boiled mutton or grilled fish, or as complex as the long historical gavotte of cultural advance, embrace and retreat that formed the character of this region's many lands.

The culinary history of the Mediterranean Basin is a big topic, and food writer Clifford Wright has written a big book. More than 800 pages long, *A Mediterranean Feast* lists more than 500 recipes and includes dozens of boxed asides describing particular ingredients, dishes and regional styles of cooking. It examines foods from every region bordering the Mediterranean and from that sea's principal islands; foods grown in the soil and foods taken from the water. It looks at food as sustenance—caloric fuel for those who work the land—and foods that, through their distinctive combinations of ingredients, flavorings and cooking techniques, exemplify regional cuisines. It considers how terrain and climate influenced Mediterranean diets, and reviews the centuries-long history of cultural and economic exchange that produced the cuisines that travelers in the region encounter today.

This is far too much territory for any book to cover in depth. Still, this volume offers a fine overview of the history, culture and character of Mediterranean food and cooking. Wright develops his discussion around three general themes. First, he argues that many of the features defining Mediterranean cuisines result from their development in a landscape "of poverty and destitution." Second, he emphasizes the significance of Islamic cuisines on the culinary history of the region. Finally, he presents a selection of recipes that reflects both the distinctive characters of the area's diverse regional cuisines and the common features that link these cuisines into a coherent Mediterranean whole.

Pomegranates were introduced into Italian cuisine in the 1200s.

Was life in the lands around the Mediterranean Sea really as wretched during the past thousand years as Wright implies? There were certainly episodes of famine and plague, and the region's great empires and splendid cities did rest on an underclass of impoverished farmers, fishermen and herders. But the worst thing about most people's fare—particularly in the lands of southern Europe—was probably the lack of day-to-day variety.

Before Columbus reached the West Indies, the Old World had no corn, squash, tomatoes, potatoes or peppers. Anything that wasn't eaten fresh had to be dried, smoked, salted, fermented or pickled. Few households had ovens, and spices like saffron, pepper and cinnamon were too expensive for any but the rich. People ate what was in season, what they could preserve, and most of all, what they could afford.

In southern Europe, people ate cabbage. They ate olives and cheese, ham and salted fish. They ate soups and stews flavored with garlic and onions, gnawed on coarse breads and slurped bowls of thick gruel. They had spinach and chard and beets from their household gardens, turnips in the wintertime and whatever greens and mushrooms they could gather in the wild. When they had fresh meat, they ate it grilled or boiled, and when they butchered an animal, they used everything except the squeal. Spices were indeed a luxury, as were rice and white bread. Most Mediterranean people were peasants, and they ate peasant food.

Wright's recipes emphasize this heritage. The first recipe he prints is for cabbage soup. He gives us recipes for chickpea and tripe stew (from Andalusia, in southern Spain), a salad of sliced duck gizzard and greens (from the Languedoc region of southwestern France), and a northern Italian dish of polenta (fried corn mush) and small birds. He tells us how to make sausage and lists six dishes featuring salt cod. Although hardly ele-

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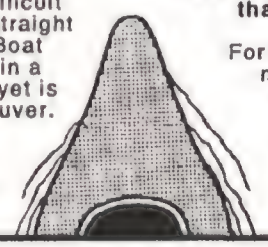

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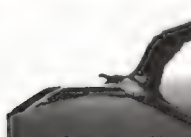

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White beans, now a Mediterranean staple, originated in the New World.

*Islamic civilization brought couscous and cinnamon, citrus and eggplant and artichokes.*

gant, this is still savory stuff, particularly with the addition of a bit of black pepper and some New World tomatoes. Such recipes also show how many ingredients we regard as luxuries—mesclun greens and wild mushrooms, prosciutto and pine nuts, good olive oil and parmesan cheese—added flavor and variety to the food on peasants' plates.

The foods of southern Europe are only one part of Wright's book. Islamic civilization brought couscous and cinnamon, citrus and sumac, eggplant and artichokes to the Mediterranean feast, along with practices like sweetening food with sugar, coloring it with saffron and flavoring it with pomegranate juice, rose water or almonds. Yogurt and stuffed vegetables arrived by way of the Middle East, along with kabobs and pilaf-style steamed rice. The author's discussion of the cuisines of North Africa, Egypt and the Arab Levant will be particularly interesting to readers who, like me, tend to think "Italy" when we hear a mention of Mediterranean foods.

Wright is particularly adept at showing how such foods, and their associated styles of cooking, were moved around the Mediterranean by migration and trade. Gyros and stuffed grape leaves came to Greece from Turkey, and dishes like spinach with raisins and pine nuts, almond and saffron soup, and a flavorful mix of rice and beans called "Moors and Christians" reveal the Muslim presence in medieval Spain. And in honor of Sicily's location at the nexus of this Mediterranean exchange, the book includes more than three dozen recipes from that rocky island.

At first glance, this book seems a jumble of topics, traditions, tastes and techniques. Broad reviews of political and economic history are interspersed with discussions of topics like shipbuilding, irrigation, spices and the Mediterranean grain trade. Recipes for seafood, lamb, pasta and vegetables are scattered throughout the book; recipes from different regions are shuffled together like a deck of cards. But two good indexes—one of general topics, the other of recipes—guide readers through the confusion; the recipes I tested were very good. Wright's enthusiastic investigation of Mediterranean cuisines is a fine feast for readers interested in culture, history, and most of all, food.

*John R. Alden returned from his most recent trip to the Mediterranean with a collection of 17 different Andalusian olive oils.*

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THE LAST PAGE

# Good-bye, Rhode Island

BY DONALD DALE JACKSON

RHODE ISLAND SHOULD BE ELIMinated. I know it sounds harsh, but Rhode Island is too small to be a state, and it occupies space nature intended to be part of Connecticut. The millennium is the time for bold initiatives, and so, my friends, I say abolish Rhode Island now.

People from Rhode Island will no doubt fuss and whine about this, but we must ignore them. If God or George Washington really wanted a Rhode Island, He (or he) would have made it bigger and more important. Even its name is meaningless: Who was Rhode, and where is the island?

It will be necessary, of course, to clear out all the old Rhode Island artifacts: the state government, laws, buildings, officeholders, license plates, fax machines, stationery and the like. The official flatware, ashtrays and such will probably appeal to antiques dealers. If there is anything we want to save, we can just overprint Connecticut's name on it.

The case for the elimination of Rhode Island is based on geographic integrity. If you have any doubts, you need only look at the map. New England, as you can see, is a top-heavy protrusion squared off at the bottom that juts out from the nation's northeast corner. Maine of course takes up all the uneven, misshapen space at the top right, which is fine for Maine, because nobody pays attention to Maine anyway.

New Hampshire and Vermont, by contrast, fit together in a perfectly tidy and orderly Yankee way, one bulging a bit in the north and the other doing the same in the south. They couldn't be a better match. Beneath them, Massachusetts occupies a sensible, rectangular slab of territory with a somewhat untidy slop-over at Cape Cod. But everything about Cape Cod is so totally endemic to Massachusetts that there is no point quibbling about it. Rhode Island, I'm afraid, is something else. Rhode Island does not compute.

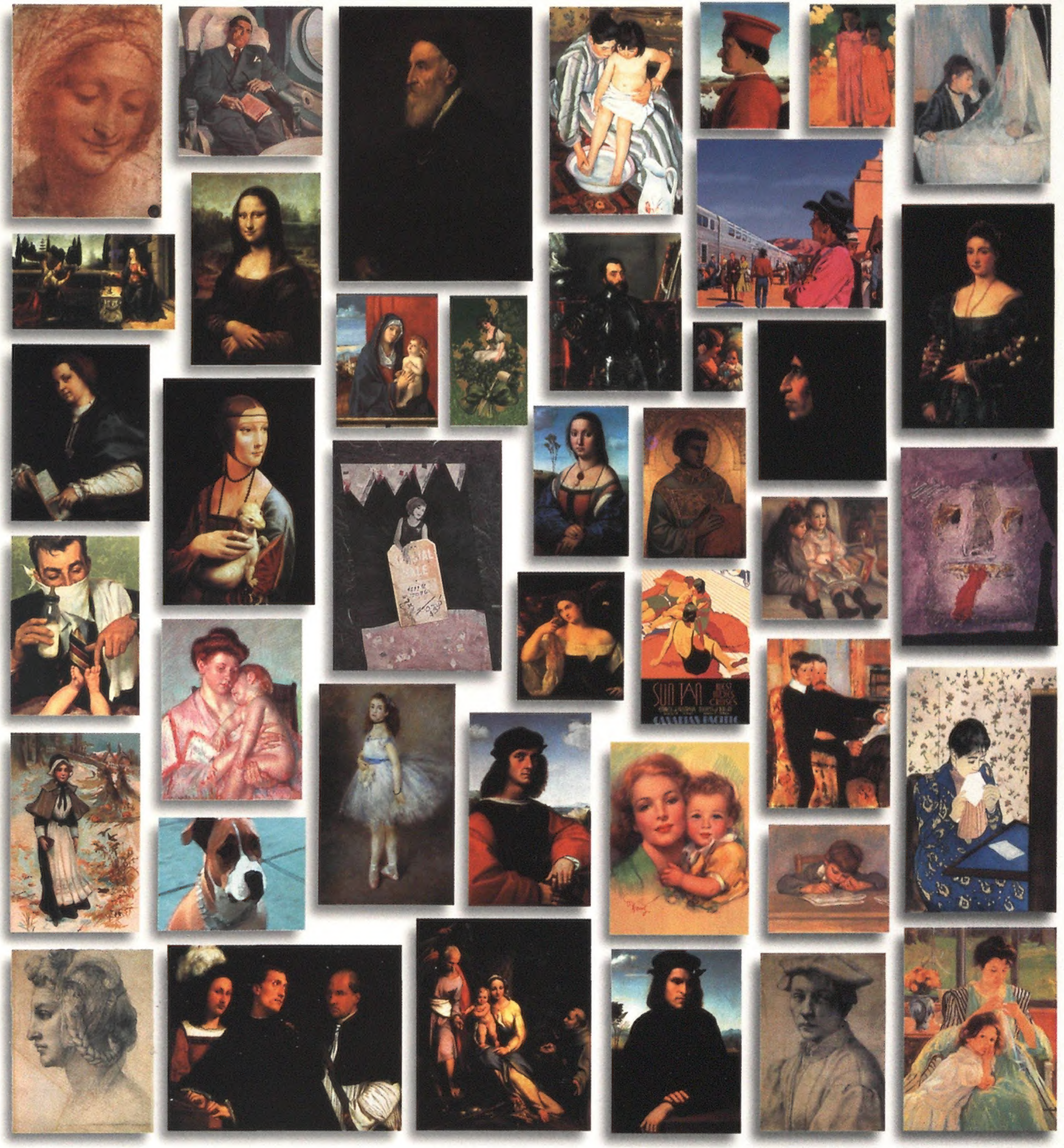
Look at the way it cringes there, occupying a sliver of land so inconsequential that the names of its cities and towns have to be entered vertically on the map. It is foolish for something so microscopic to go around posing as a state. Anyone who has ever been there knows what I mean. You drive into Rhode Island, nod off for 10 or 20 minutes or embark on an interesting conversation and—*zap*—you're in Massachusetts. You're out of the place before you can settle into it. Flying over Little Rhody is absurdity itself; you can traverse it in the middle of a sentence.

I bear no rancor toward Rhode Island, you understand, and I want to make it clear that this is my idea and mine alone, and I am attached to no organized political party. The credit or blame should rest with me, not Republicans or Democrats or whatever it is Ross Perot and Donald Trump are this year. The idea came to me as I studied a topographic map of New England one day while looking for excuses to avoid raking the leaves. I know some people will think it's significant that I come from Connecticut, and they'll see this as some sort of Nutmeg State power play, but it's not. I'm not even sure Connecticut wants the extra territory. It's just common sense.

I don't know what the next step should be if this idea is going to go anywhere. We'll probably need a committee, somebody to handle public relations, maybe a lawyer. I'm for minimizing public input, and doing our work as bloodlessly as possible. Rhode Islanders will just whimper and carry on if we let them in on this. Some will probably take it hard, but I think that in time they'll adjust. They'll need strength and maturity.

If you want to join me in this campaign, I'll be launching a mailing that will let you know where to send money. We're going to need a bundle of cash to remove one star from every American flag in the country. It's a big job, yes, but not an impossible one. And if anyone from Rhode Island wants to write and discuss this, I'll be letting you know the address just as soon as I set up an unlisted, untraceable mail drop.

MATT WUERKER

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